BUREAU OF FISHERIES

REPORT

OF THE

UNITED STATES COMMISSIONER OF FISHERIES

FOR THE FISCAL YEAR 1919

WITH

APPENDIXES

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WASHINGTON
GOVERNMENT PRINTING OFFICE
1921

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OF THE

COMMISSIONER OF FISHERIES.

Department of Commerce,
Bureau of Fisheries,
Washington, October 10, 1919.

Sir: In presenting this report in which is given a résumé of the varied activities of the Bureau of Fisheries for the fiscal year ending June 30, 1919, I take the liberty to express appreciation of your sustained interest in and ever-ready, helpful criticism of the Bureau's work and to acknowledge your potent assistance which has made it possible for the Bureau to assume larger functions of public usefulness than it ever had before and has prepared the way for still greater service and achievement. To state that you have made permanent impress on this Bureau's career is but to repeat what is generally held by the responsible employees in office and field.

This occasion is taken to reaffirm the critical condition that has been created by the long continuance of inadequate compensation in all grades of the service. The prospective recommendations of the Joint Congressional Commission on the Reclassification of Salaries are confidently expected to meet and counteract the disorganizing situation now confronting the office force in Washington; but the labors of the commission will be futile, so far as this Bureau is concerned, if provision is not speedily made by Congress for the rectification of salaries in the field.

RELATIONS WITH THE FISHERY INDUSTRIES.

SUMMARY OF ACTIVITIES.

Inasmuch as outside of Alaska the Bureau exercises no jurisdiction over the fisheries, its relations therewith are necessarily confined to advisory, investigational, educational, and informative work to meet the special requirements of the country at large, the individual States, and various branches of the fishery industries.

The need for food production and food conservation during the war and post-war periods has afforded unprecedented opportunities for increasing the consumption of fish and incidentally for developing uses for by-products of the fisheries. Appreciative of these opportunities, and being desirous of contributing its full share of effort during the great national emergency, the Bureau has made use of all available means to secure the fullest practicable utilization of the country's aquatic resources. To this end it has cooperated effectively

with Federal and State food administration representatives and other governmental agencies, with producers, with the trade, with civic organizations, and with other elements of the population. By lectures and practical demonstrations it has shown directly to some fifteen thousand housewives the value of fish as food and the best and most economical methods of preparing it for the table, and in this way it has been enabled to show the merits of many of the little-used or neglected fishes which are fully the equal of more valued species, thereby increasing the fisheries and the markets for such forms at a time when they were needed most. It has augumented materially the saving and use of waste products of the fisheries, as, for example, the conversion of fish waste and waste fish into oil and fish scrap for fertilizer or fish meal as an animal feed, and the making of leather from the skins of aquatic animals. New or foreign methods of preservation have been introduced and wasteful practices have been discouraged. Investigations of the basic principles governing the methods of preservation of fishery products, for which there is a long-felt want, have been initiated and are yielding important results. A fishery-products laboratory in which such investigations can be continued under accurately controlled conditions has been built and equipped, and a temporary experimental field laboratory has been placed in operation.

The Bureau has also given greater attention to the collection of fishery statistics, which afford the only available, reliable basis for determining the condition and trend of the commercial fisheries of the country, serve as a guide for the enactment of necessary protective legislation, and indicate the need for and results of fish-cultural operations. The monthly returns of the quantities and values of the fish landed at Boston and Gloucester, Mass.; Portland, Me.; and Seattle, Wash., by American and Canadian vessels have been submitted by local agents and published as monthly and annual bulletins for the use of the trade. A statistical canvass of the fisheries of the Great Lakes, together with Lake of the Woods, Rainy Lake, and Lakes Kabetogama and La Croix, was made during the year, and a special bulletin on the subject was issued. In addition, there have been initiated and are nearing completion a comprehensive canvass of the fisheries of the South Atlantic and Gulf States for the calendar year 1918, and canvasses of the shad and river-herring fisheries of the Potomac River and of the shad fishery of the Hudson River for the calendar year 1919.

Plans are being developed for taking statistical canvasses with sufficient frequency to include all of the major geographical divisions of the fisheries once in a five-year period. To complete this work satisfactorily and take up such special canvasses as are required from time to time will require a somewhat larger force of statistical agents and clerks.

INCREASING PRODUCTION AND CONSUMPTION OF FISHERY PRODUCTS.

The Bureau has encouraged west-coast whaling companies to save and market whale meat for food and has rendered effective assistance in bringing the merits of whale meat to the attention of consumers. In 1918, 30,000 cases of the meat were canned and 195 tons were frozen for market, the latter being utterly inadequate to supply the demand. Equipment has now been provided for an output of 50,000 cases of

canned meat and 1,000 tons of frozen meat in 1919. Samples of the canned meat examined by the Bureau were found to be of good quality and to constitute a cheap and wholesome food. It is reported that in 1918 the principal whaling company on the Pacific coast, with stations in Washington, British Columbia, and Alaska, took 999 whales, of which about 200 were of the sei species (*Balænoptera borealis*) whose meat is light-colored and particularly good for canning. Attention has been given to the renewal off the coast of Maine of a fishery for whales, the flesh of which is to be marketed for food, and various persons connected with the fisheries are considering the practicability of such an undertaking. Interest has been aroused in Texas in the use of the meat of porpoises, which are reported to occur in numbers on the coast of that State. It has been ascertained that the oily taste which may be more or less objectionable to some persons can be overcome by removing the connective tissue which lies between the blubber and the meat. Some difficulty was experienced in inducing fishermen to provide the markets with supplies sufficient to satisfy the demand. An economic circular containing 32 recipes for preparing the meat of whales and porpoises for the table has been issued.

Being convinced that the production of fish in the States bordering on the Gulf of Mexico could be materially increased if larger markets to care for the surplus catch were provided, the Bureau cooperated with representatives of the Department of Agriculture and the Food Administration in securing the introduction of Gulf fish into Nashville, Louisville, Indianapolis, and neighboring points, and introduced approximately half a million pounds of fish from points in Florida into these cities. To effect relief for unsatisfactory shipping conditions, similar service was inaugurated between Chincoteague, Va., and the markets of Philadelphia and New York, and a number of shipments were made under supervision of Government agents.

Nearly 14,000 cases of canned river-herring products (fish, roe, and buckroe), sea herring and gadoid buckroe, valued at over $54,000, were introduced to the markets of Atlanta, Birmingham, Montgomery, Knoxville, Nashville, and Chattanooga, largely as a result of exploitation work conducted by agents of the Bureau.

On the fishing banks in the Gulf of Mexico groupers are more abundant than snappers. The demand for snappers has been in excess of the supply, while that for groupers has normally been insufficient to care for more than half of the catch, with the result that quantities of these wholesome, white-meated fishes have been wasted, and valuable time has been lost by the fishermen in searching for the highly prized snappers. During the war, owing to the reduction in the size of the fleet, most of the groupers taken could be marketed. Recently, with an increase in the number of vessels operating, the catch has again exceeded the demand. The Bureau has, therefore, carried on extensive exploitation measures in inland cities of the South in an effort to stimulate sufficient demand to care for the entire catch. Restaurants and cafés, in particular, have been encouraged to use these fishes. A placard recommending groupers and an economic circular containing 29 recipes for preparing them for the table have been issued for the use of the trade.

The lack of a market for the catch of black drum, the destructiveness of this fish to oysters, and the excellent quality of the canned

product have led the Bureau to undertake a special movement to popularize the fish, and an assistant was detailed to visit fishing centers on the Gulf coast for detailed information regarding abundance, seasons, etc. Of points on the Florida coast, Cedar Keys appears best suited for the establishment of a fishery, the fish being reported as plentiful throughout the year. An even larger supply appears to be available at Point Isabel, Tex., where about 70 per cent of all fish taken is reported to be black drum. At this place the fish are caught throughout the year with pocket nets; that is, drag seines provided with pockets. The information gathered will be brought to the attention of those interested in establishing a fishery or a cannery for this fish.

Efforts have been put forth to stimulate the production and consumption of many other products, including alewives or river herrings, carp, crevalles, eulachon, red drum, robalo, rockfishes, sea catfish, rays, sharks (fresh, salted, and smoked), the roe and buckroe of fishes, sea mussels (canned), squid, etc.

DEMONSTRATIONS IN FISH COOKERY.

No recent activity of the Bureau in the field of practical fishery work has met with such universal favor among producers, dealers, and consumers as its lectures and demonstrations in the methods of preparing and cooking fish.

Demonstrations were first given in Seattle, Wash., in May, 1918, with the object of showing housewives the best and most economical methods of preparing and cooking fish and of acquainting them with the merits of many of the common fish and fishery products with which they had little or no acquaintance. This work was extended to 15 other cities and towns in the States of Washington, Oregon, and California, and was highly commended in every center. In February, 1919, when the supplies of fish in the cold storages of the country were about double the normal holdings and there was imminent the possibility that large quantities of this good food might have to be destroyed for lack of markets, the demonstrators were detailed to the Middle West, to give a series of demonstrations in St. Louis, Chicago, St. Paul, Minneapolis, Cincinnati, and Cleveland. At these meetings housewives were encouraged to use frozen fish and were given instructions in buying and preparing them for the table. Stewards' associations, home demonstration workers, food-conservation officials, community-service organizations, and others were interested and benefited by the instructions given. The value of the work was well vouched for by the trade in its reports of increased demand for frozen fish, and many housewives commented on their previous failure to use such fish, believing them to be of poor quality, if not actually unfit for food. In May a successful series of demonstrations was held in Boston and Cambridge, Mass., after which the work was brought to a close for lack of funds.

To enable State and local agents of the States Relations Service of the Department of Agriculture to carry the benefits of this work to the housewives of their respective communities, demonstrations were given in St. Augustine, Titusville, Miami, West Palm Beach, and Key West, Fla.; at the Agricultural and Mechanical College of

Mississippi; in Savannah and Valdosta, Ga.; and before a gathering of State agents in Washington, D. C.

In all, some 125 demonstrations were given, the average attendance being about 100 persons. In this work the Bureau was particularly fortunate in obtaining the services of a highly trained and skillful demonstrator, ably assisted by two persons, one of whom was a man with wide acquaintance with the fisheries. From every city in which demonstrations have taken place expressions of appreciation of their usefulness and importance have been received, and many women have acknowledged that they had been using little or no fish, largely because of some groundless prejudice, and have testified to the value of this work to them.

This entire program was made possible at a most opportune time by the use of money alloted by the President from the fund for the national security and defence. The total cost of the work was less than $12,000. It is with very great regret that announcement must be made of the failure of Congress to grant any money or authority for continuing this highly beneficent service.

FISH-COOKERY EXPERIMENTS.

As an essential factor in the Bureau's campaign for inducing the wider use of aquatic products as food, more particularly those that have been wholly or partly neglected, an experimental kitchen has been equipped, and workers expert in domestic science have been employed to determine the best methods for preparing new or little-known fishery products for the table. The information assembled has in some cases been forwarded directly to the trade, in others it has been arranged for publication in the Bureau's economic circulars to further the use of particular products. In addition, a cookbook on aquatic foods has been prepared for publication.

INCREASING THE USE OF WASTE PRODUCTS OF FISHERIES.

There is, on one hand, an increasing demand for new and enlarged sources of supply of protein feeds for hogs, cattle, and poultry, and of oils suitable for paints, varnishes, hydrogenation, and many other uses. Considerable quantities of fish waste and waste fish, on the other hand, which should be used to supply these deficiencies remain unutilized for lack of small, inexpensive plants suitable for caring for this waste, and because of lack of knowledge on the part of possible producers of apparatus and methods required and other difficulties by no means insurmountable.

The Bureau needs, and has made request for, the creation by Congress of a new position so as to permit the employment of a properly trained technologist to devote his entire time to these problems. Such work would annually result in the saving of fishery products possessing a value many times the cost of investigations. In the absence of proper provision for this work, the Bureau is attempting to render such service as its limited facilities will permit.

Encouragement has been given to manufacturers of fish scrap to convert all suitable material into fish meal as feed for domestic animals. Attention has been directed to the perfection of details of manufacture, and, as a result of these efforts, manufacturers in

the Chesapeake Bay region are prepared to produce and market from 2,000 to 5,000 tons of this feed in the 1919 season, provided a sufficient number of users of such feed can be acquainted with its merits and interested to purchase it. In the development of markets and in acquainting farmers with the value of such feeds, the Bureau of Animal Industry of the Department of Agriculture is lending effective cooperation. It is also conducting hog-feeding experiments with meal made from fish and fishery products, as, for example, menhaden meal, grayfish meal, and shrimp bran, to determine their quality as compared with other feeds. Such tests as have been completed indicate that fish meal is fully the equal of tankage.

On the west coast, including Alaska, the increasing demand for fish meal is reflected in the rapid increase in production. According to the Pacific Fisherman, the production in 1916 amounted to 2,640 tons of meal and 776 tons of fertilizer, in 1917 to 5,297 tons of meal and 1,390 tons of fertilizer, and in 1918 to 7,773 tons of meal and 802 tons of fertilizer, all of which was inadequate to satisfy the demand. In 1918 the reported yield of the menhaden industry of the Atlantic seaboard was 16,017 tons of dried scrap, much of which it is believed could better have been made into fish meal, and 33,187 tons of acidulated scrap.

During the war fish oils commanded unusually high prices, followed by a decided drop after the signing of the armistice. As a result of the increasing demand for these oils, prices have since approached their former high level. The falling off of the flax crop, the lack of supply, and the abnormally high prices of linseed oil have compelled the paint industry to seek new sources of drying oils required in paints and varnishes. It is believed that in the future menhaden oil and possibly other fish oils will be more extensively used in making certain types of paints and varnishes. Investigations to determine the fitness of various fish oils for such purposes have been arranged for. It is estimated that the production of fish oils in the United States, including Alaska, in 1918 amounted to approximately 6,000,000 gallons, of which 3,943,100 gallons were menhaden oil, a considerable increase over 1917 for both items.

In addition to the foregoing work, the Bureau has given attention to the possibilities of increasing the use of shrimp waste, to the methods of handling fish waste and waste fish employed in California, and to assembling samples of meal and oil for chemical examination, and has furnished a large number of interested correspondents with literature on the subject, including extracts from various publications not readily obtainable, and has placed them in touch with manufacturers of machinery employed in the industry and with markets for the products.

DEVELOPMENT OF AQUATIC SOURCES OF LEATHER.

The development of the aquatic leather industry, to which the Bureau has been giving considerable attention, has progressed satisfactorily. Nets of the special type developed by the Bureau for the capture of sharks and other powerful fishes are now being employed in taking these forms in commercial quantities. One leather company has established fishing plants at Morehead City, N. C., and Fort, Myers, Fla., to provide regular supplies of shark hides for tan-

ning purposes, and has a tannery for converting these into leather. Another company has acquired a site at Edmunds, Wash., where it plans to tan and finish into leather all kinds of aquatic hides, such as sharks, whales, hair seals, etc. Other companies are experimenting with these products and will later engage in the industry.

Difficulty was at first experienced in removing the shagreen from shark skins in a satisfactory manner. Suitable methods have now been devised for doing this before the sharks are skinned and from the cured skins as well, and the removal of the shagreen has also been accomplished at the close of the tanning process.

Following the Bureau's suggestions, all parts of the shark are now being utilized. Besides using the skins for tanning into leather, the valuable liver oil is extracted and marketed, the remainder of the fish is converted into fertilizer or fish meal, and experiments are in progress to develop suitable methods of preserving the flesh for food purposes. The Washington Institute of Industrial Research is cooperating with the Bureau to determine the fitness of shark, grayfish, and skate-liver oil as a drying oil for making paint and varnish. It is claimed that these products have sufficient value to support the fishery, thus permitting excellent leather to be made from the hides at low cost.

According to the Bureau of Standards, which has been cooperating with the Bureau of Fisheries in this work, fish leather such as that made from shark skin has a more spongy and fibrous texture than mammal leather. When pulled open at right angles to the surface, it often exhibits a laminated structure similar in appearance to that of a loosly-matted felt. Material is being assembled to enable that bureau to determine more definitely the qualities of fish leather, such as durability, pliability, porosity, water absorption, wearing qualities, and to make further tests as to tensile strength. Tests made at the Bureau of Standards of such samples as have been submitted indicate that fish leather usually possesses less strength than mammal leather, such as calfskin or cowhide, but that it is soft and pliable and has ample strength for many uses. As the industry grows it is expected that special uses will be found, dependent upon the inherent differences of hides from different fishes. One such use to which attention is being given is the employment of pieces of grayfish skin in place of the usual clip or fastener on garters, the small denticles catching in the webbing of the stocking.

Leathers of excellent appearance and quality are now being made from porpoise hides, and it is believed that hereafter the skins of these animals will be utilized, not wasted.

As the hides of the sharks give the greatest promise because of size, abundance, and quality, the Bureau is continuing to devote special attention to the development of the shark fishery and to determining definitely the properties of the various products and the uses to which they are best adapted. It has been the practice of fishermen to operate most intensively for those fishes for which the demand is greatest and to permit such predatory forms as the sharks, possessing little or no value, to multiply and to increase their depredations upon the more highly prized forms. This is an added reason for the development of a fishery for sharks and of uses for the products.

PRINCIPLES GOVERNING PRESERVATION OF FISH BY SALTING.

During the lack of proper laboratory facilities the Bureau, with the cooperation of the National Research Council, was enabled to carry on at Johns Hopkins University Medical School, Baltimore, Md., an investigation of the problems of preserving fish with salt, and Dr. E. V. McCollum kindly volunteered to supervise the work at that institution. Experiments were conducted later at fishing centers in Virginia, North Carolina, and Florida.

The primary object of the investigation was to devise an improvement in the present methods of salting fish and to find an acceptable way of salting fish at summer temperatures, particularly in the Southern States, where difficulty in the warm months is encountered.

Incidentally, the work has added materially to our knowledge of the basic principles governing the salting process. The fish used in the experimental work were squeteague and river herring. The rate of penetration of salt into fish and the decomposition of the protein, as indicated by the amount of amino-acid nitrogen formed, were used as criteria of the efficiency of salting methods.

Sulphates and also salts of calcium and magnesium, as impurities in common salt, were found to retard the penetration of salt into fish muscle, but to produce a firmer, whiter flesh than pure sodium chloride. By reason of retarded penetration, salt containing these impurities permits fish to spoil at a lower temperature than salt not containing such impurities. Of these deleterious substances, the calcium salts are the only ones present in commercial salt in a large enough quantity to have a marked effect on the quality of the fish.

The removal of all blood and viscera, including roe and milt, appears to be an important factor in the salting of fish in warm climates. Experiments made indicate that the blood spoils at a temperature at least 25° F. lower than the spoilage temperature of the flesh of fish.

An investigation of the chemical changes taking place in the fat and protein of fish during storage is in progress, and a report of the completed work is being prepared for publication.

DEVELOPMENT OF A PROCESS FOR RECOVERY OF WASTE BRINE.

It has been the usual practice among fish curers to discard the used brine employed in brine-salting fish, and also to some extent in the dry-salt process, and to make new brine for new lots of fish. Much salt has been wasted, the recovery of which was impracticable for a number of reasons. For example, the brine is loaded with a large amount of organic matter, blood, mucus, soluble proteins, methylamines, bacteria, etc., whose removal would be expensive; and, since salt was comparatively cheap and used in large quantities, any recovery process must of necessity produce results at low cost.

Recent investigations of the Bureau have shown that a better quality of fish may be produced by using higher grades of salt and have indicated the possibility that salting could be successfully accomplished in warmer climates. Without some recovery process the cost of refined salts may be prohibitive.

For these reasons the Bureau undertook to develop a process of purifying fish brine without expensive evaporation. Advantage was taken of the absorption by exceedingly fine precipitated particles of a tasteless and inert substance of the suspended and dissolved

organic matter, which is subject to decay. It has been demonstrated that the precipitate does remove most of the organic matter, and a plant has been installed in a fish-packing establishment at Gloucester, Mass., for trial. If this recovered brine can be rendered suitable for use again, the old brine used in preserving the fish brought to this plant will, when recovered, supply most of the salt needed for future use. At the present time, when the price of salt is about $16 per ton, as compared with $3 three years ago, this is an item of importance. The recovery process provides for the filtering off and drying of the precipitate, a product rich in protein which may be converted into fertilizer or fish meal. It is expected that this process, in conjunction with improved methods of salting requiring high-grade salt, to which reference has been made, will mark an advance in salting methods. The development of a practicable recovery process should enable the fish trade to use high-quality domestic salts in place of crude foreign grades.

As this work is still in the experimental stage, the results, including complete description of details of apparatus, will not be disclosed until the practicability of the method has been satisfactorily demonstrated.

URGENT NEED FOR EXHAUSTIVE INVESTIGATIONS OF PRESERVING METHODS.

In no branch of the fisheries is there greater need for exhaustive study than in the methods of preservation of fishery products. The methods in common practice are largely empirical, and in many cases the basic principles governing the operation are not definitely known. There is waste of time, labor, fuel, and materials, and the fisheries remain undeveloped from the lack of knowledge of suitable methods. To solve problems which in many cases are of vital importance to the welfare of communities, well-equipped fishery-products laboratories and a well-trained corps of skilled technologists are required. With adequate provision for these it would be possible to conduct many important investigations under accurately controlled conditions and render inestimable service in developing the fishery industries. To appreciate the handicap under which the fisheries labor, one has but to recall how amply agriculture is supplied with both Federal and State experiment stations, with skilled investigators and agriculturists trained in colleges and universities provided for the purpose, and how greatly it has benefited thereby, while the fisheries have utterly lacked any such advantages, and their development has in consequence been retarded. During the past year provision has been made for one such laboratory for the Bureau, and one university has established a college of fisheries in which the methods and problems of the fisheries will receive carful study and a corps of students will be trained for the industry.

FISHERY PRODUCTS LABORATORIES.

Through an allotment of $125,000 from the fund for the national security and defense, approved and authorized by the President on July 2, 1918, the Bureau has been enabled to build a fishery-products

laboratory in Washington, D. C., to provide equipment, and to initiate investigations of importance to the industry.

The building is 45 by 80 feet, with two floors and an attic, and is of hollow-tile and concrete construction. On the first floor there are a large mechanical laboratory, low-temperature rooms for storage and refrigeration, chemical laboratory, incubation room, stock room, and a built-in smokehouse. On the second floor there are a laboratory, a fishery-products exhibit and demonstration room, an experimental kitchen, and offices.

The mechanical laboratory contains equipment for the canning, freezing in brine, drying, and smoking of fishery products, hydraulic press, filter press, grinder, steam boiler, vacuum and compressed air pumps, and various other appliances. For canning purposes there are a complete plant for sealing the cans by a double seamer, a retort with controlling and recording instruments, complete apparatus for sealing and processing glass containers by vacuum process, and another apparatus for processing tin containers, also by a vacuum process. In the experimental drier the heat, humidity of the air, and volume of air driven over the product can be controlled and registered and the weight of the material can be recorded, so that the exact conditions governing the drying of various fishery products may be worked out. An experimental plant for freezing fish in brine has been imported from Denmark and has been shown to persons interested in refrigeration. This plant, which was the first of its kind to be brought to and used in this country, enables the Bureau to demonstrate to the trade a new method and to afford the scientific staff of the laboratory a means of investigating the various types of brine freezing and comparing them with the customary freezing in air. The built-in smokehouse is of hollow-tile and cement construction, lined with white, glazed wall tile, provided with a flue, iron door, ventilators, shaving pans heated with gas, long-distance recording thermometer, and dampers for control of heat and ventilation.

The refrigeration plant is equipped with a 5-ton carbon-dioxide machine, and three rooms of different temperature are provided. The chemical laboratory is supplied with soapstone furniture, improved cabinets for classifying and holding chemical stock, viscosimeter, refractometer, polarimeter, colorimeter, specific-gravity balances, supercentrifuge, apparatus for determination of amino groups, apparatus for gas analysis, and other equipment needful for chemical study of materials and processes. That the factors which influence the character of the product may be known, measured, and controlled, provision has been made for recording hygrometers and thermometers, thermostats, pitot tubes, and pressure and vacuum gauges.

In the absence of a laboratory of this kind for a guide, much study and effort had to be expended in working out plans and details of equipment. The building was completed during the year, and several important investigations therein have already been instituted.

This laboratory has been planned and equipped for the study of the general problems of the industry, to enable its investigators to try out new methods and suggestions for improvement of common practices, and to overcome difficulties encountered in the field. It is intended for a workshop in which the properties of fishes and fishery products may be subjected to careful and thorough investigation and uses developed therefor, a place in which to perform the

manifold examinations and analyses demanded of this Bureau in the interests of the fisheries.

There is need for other similar laboratories in or near an important fishing center in each of the main geographical divisions of the country, for the study of the special problems of those divisions, for the conduct of investigations which can only be conducted at the seat of the industry, and for aiding in the perfection of apparatus and methods used in the capture, preservation, and preparation for market of the fishes of the region. The work of each of such laboratories should be under the direction of the Washington laboratory and coordinated with it and with the laboratories in other centers.

On the coast of California there is now special need for work in this field. Although noteworthy progress has been made in the development of its fisheries, for example, those for tuna and sardines, there are still large, undeveloped fishery resources in the barracuda, mackerel, rockfishes, etc. Desirous of lending assistance to the fishery industries of this region, provision has been made for a temporary laboratory for the study of some of the more pressing problems.

After some six weeks study of the advantages of the various fishing centers of southern California, suitable temporary quarters in San Pedro were obtained for the establishment of a small experimental plant. The equipment of this plant was completed within three months, and during May and June, 1919, investigations in the canning of mackerel, barracuda, rockfishes, smelt, pilchards, and tuna were initiated. According to a schedule which has been worked out, each species is subjected to 16 preliminary methods of packing, all of which may be run at one time. At the conclusion of the canning the packs are subjected to uniform storage conditions. At the end of six weeks these preliminary packs are examined as to firmness, appearance, taste, quality, etc., and analyzed to determine whether there has been a chemical change. Adopting the methods of the most promising of the preliminary packs, finished packs—that is, packs to which condiments or special packing oils have been added or in which the fish is subjected to some special treatment—are next put up. These final packs range from the simplest and most inexpensive to the most complicated and exclusive form of treatment. In order to determine the keeping qualities of the various methods with reasonable certainty, it is planned to examine samples at the end of 3, 6, and 12 months. If the product is in good condition and excellent in quality at the end of a year, it is felt that the process may be given to the trade. Careful records are kept of all operations and of the weight and amount of ingredients used. If the market price of ingredients is known, it will be possible at any time to determine the cost per case. Perhaps the most promising of the packs made during the year were those of the mackerel packed in olive oil, tuna style, and kippered and canned in cottonseed, corn, or olive oil. This species, generally known on the east coast as chub mackerel, is reported to be very abundant, but owing to the limited demand comparatively small quantities are now brought in by the California fishermen.

NEW ENGLAND VESSEL FISHERIES.

The vessel fisheries at Boston and Gloucester, Mass., and Portland, Me., the three principal New England fishing ports, were more than ordinarily prosperous during the calendar year 1918, notwithstanding

the presence of enemy submarines along the coast and on the fishing grounds for some time during the summer and the consequent loss of a number of fishing vessels. This condition was due largely to the increased demand for fishery products and the prevailing high prices during the war period.

The fishing fleet discharging at these ports in 1918 comprised 521 sail, steam, and gasoline screw vessels. They landed at Boston 2,830 trips with 109,476,041 pounds of fish, valued at $6,587,754; at Gloucester 3,414 trips with 74,175,499 pounds, valued at $3,062,605; and at Portland 2,506 trips with 21,849,613 pounds, valued at $881,189; a total of 8,750 trips and of 205,501,153 pounds of fresh and salted fish, having a value to the fishermen of $10,531,548. This total includes 60 trips landed at these ports by 21 Canadian fishing vessels, amounting to 5,602,749 pounds of fresh fish, valued at $218,625. These fish were landed in accordance with an arrangement with the Canadian Government, as an emergency war measure, granting reciprocal privileges to fishing vessels of both countries, one feature of which was that Canadian fishing vessels were permitted to land their fares at American ports directly from the fishing grounds. Canadian fishing vessels began to utilize this privilege in April and continued during the remainder of the year. The larger part of these fish, or 4,668,620 pounds, valued at $164,946, were landed at Portland.

There was a decrease of 534 trips in the total number for the three ports as compared with the previous year, but an increase of 30,070,567 pounds, or 17.14 per cent, in the quantity, and of $2,170,216, or 25.95 per cent, in the value of the fish landed. The catch of cod increased 27.19 per cent in quantity and 52.57 per cent in value; haddock, 24.49 per cent in quantity and 27.12 per cent in value; and pollock, 83.07 per cent in quantity and 66.08 per cent in value. The catch of halibut increased less than 1 per cent in quantity, but had 37.88 per cent greater value. There was considerable falling off in both the quantity and value of hake, cusk, mackerel, swordfish, and tilefish.

The fishery products landed at these ports by fishing vessels each year are taken principally from fishing grounds lying off the coast of the United States. In the calendar year 1918, 68.10 per cent of the quantity and 70.86 per cent of the value of the catch landed by American and Canadian fishing vessels were taken from these grounds; 4.36 per cent of the quantity and 4.70 per cent of the value were from grounds off the coast of Newfoundland; and 27.52 per cent of the quantity and 24.43 per cent of the value, from fishing grounds off the Canadian Provinces. Newfoundland herring constituted 3.10 per cent of the quantity and 3.15 per cent of the value of the products landed during the year. The herring were taken on the treaty coast of Newfoundland, and the cod and other species from fishing banks on the high seas. All fish caught by American fishing vessels off the Canadian Provinces were from offshore grounds.

Cod.—Cod ranked first in importance in both quantity and value, the catch, fresh and salted, amounting to 71,824, 427 pounds, valued at $3,617,205.

Haddock.—The catch of haddock ranked second to that of cod, amounting to 66,671,541 pounds, valued at $3,199,276.

Hake.—The yield of hake has fallen off in the past few years. In 1918 the catch was 5,280,829 pounds, valued at $273,085. In 1916 over 13,000,000 pounds were taken, and in 1910 the quantity landed at Boston and Gloucester alone was nearly 20,000,000 pounds.

Pollock.—The pollock catch was much larger than usual, the quantity landed being 26,560,620 pounds, valued at $962,085.

Cusk.—The output of cusk was small as compared with recent years, amounting to only 2,658,260 pounds, valued at $103,031. The catch of this species has usually been about three million to upward of six million pounds.

Halibut.—The catch of halibut was 1,781,004 pounds, valued at $302,280, which was 14,940 pounds more than in the previous year, with $83,048 greater value.

Mackerel.—The total yield of fresh mackerel taken by the American fleet in 1918 was 69,314 barrels, compared with 111,932 barrels the previous year, a decrease of 42,618 barrels. The catch of salted mackerel was 13,030 barrels, as compared with 32,162 barrels the previous year, a decrease of 19,132 barrels. The aggregate quantity of mackerel landed at Boston, Gloucester, and Portland by the fishing fleet during the year was 10,158,467 pounds, valued at $1,188,924, of which 7,582,414 pounds, valued at $853,639, were fresh, and 2,576,053 pounds, valued at $335,285, were salted. This quantity includes 29,152 pounds of fresh mackerel, valued at $2,423, from the Cape Shore, landed by Canadian vessels.

In 1919 both the purse seiners and gill netters in the mackerel fishery had a comparatively good season. The mackerel landed by the southern fleet were mostly large and medium fish, and sold from 8 to 18 cents per pound, according to market conditions. The total catch of mackerel up to July 1 was 38,787 barrels fresh and 6,452 barrels salted, compared with 29,259 barrels fresh and 8,079 barrels salted the previous year.

PACIFIC SALMON FISHERIES.

Outside of Alaska the Bureau's connection with the salmon (and other) fisheries of the Pacific seaboard consists of very extensive cultural operations addressed to the salmons in all the coastal States, biological and other investigations of the salmons and salmon waters, and interest in the welfare of the vast industry dependent on the salmon supply.

The conduct of salmon culture is, by law, contingent on the enforcement by the States of measures for the adequate protection of the salmons, so that the money and effort devoted to the work of artificial propagation may not be wholly or partly vitiated. The question has arisen as to whether certain practices of the salmon fishermen are needlessly wasteful and destructive. If the answer is affirmative, remedial action by the States is clearly demanded if the Bureau is to continue the operation of its hatcheries.

A feature of the salmon fisheries which has attracted much attention in recent years and has been widely discussed is the taking of salmon by lines and nets at sea, on the feeding grounds of the schools, under conditions that necessarily involve the destruction of large numbers of immature fish on which the future of the industry depends. This practice which for years has been followed in Monterey Bay, Calif., has more recently been taken up and very actively engaged in off the Columbia River, off the Strait of Juan de Fuca, and to a less extent in other sections.

The Bureau conducted an inquiry into this matter by a biological assistant who is devoting his entire time to Pacific salmon problems, and in August, 1918, made known the results of the inquiry. The following data are extracted from the published report:

In Monterey Bay chinook salmon are taken exclusively by troll, and a large percentage are immature. Accurate figures are not yet available, but well over 50 per cent of the fish seen at Monterey are distinctly immature. This is shown by the age as determined by the scales, by the size of the fish, and by the size of the eggs in the ovaries.

Off the mouth of the Columbia River within the past four years trolling and purse-seining have increased rapidly. Four years ago there were no purse seines and but few troll boats operating in this section, probably not more than 20 or 30. In 1918 there were several dozen purse seiners and probably 2,000 trollers fishing just outside the mouth of the river. An examination of some of the fish brought in by this gear disclosed many immature specimens among them, although these constituted a rather small proportion of the catch at the time the examinations were made, August 12 and 13. However, at one of the canneries at Astoria there was about a ton of small fish which had been taken by troll, called locally "grayling," and a cursory examination showed that they were practically all immature. It should be noted that all reports available, derived from various sources, agree that the proportion of small and presumably immature, fish is much greater earlier in the season, particuarly during May and June.

Outside the Strait of Juan de Fuca purse-seining has been carried on for a number of years. Silver salmon constitute a large proportion of the catch. The center of the industry is at Neah Bay. A report by Dr. Charles H. Gilbert ("The Salmon of Swiftsure Bank," 1913) contains a description of the fish taken here and shows that the majority are more or less immature.

Practically all of the fish taken thus by troll and purse seine in the open ocean are feeding and their stomachs are full of food. Within a few hours after they are taken from the water auto-digestion sets in and the fish soon become soft. The ribs loosen and the bellies frequently become so soft that they break through. Such fish are spoken of as being "belly-burned." At Monterey this is not a serious matter, so far as our observation goes, as the fish are delivered soon after being caught. In the Columbia River and Puget Sound regions, however, the fish are frequently in poor condition before they are delivered. The small fish seen in Astoria were in very poor condition and appeared hardly fit for human food. They were soft and badly "belly-burned" and the odor arising from them was most unpleasant.

The economic waste resulting from this fishing may be summarized as follows:

1. *Waste resulting from the taking of fish before they have attained full size.*—A large number of these fish lack one, two, three, and even four years of being mature, and in this time would increase to from twice to 20 times the weight when taken. This loss may be to some extent offset by the fact that fish are taken which before reaching maturity would fall prey to enemies other than man. There must be, however, comparatively few fish of the size taken

by trollers and purse seiners which would thus be captured by predacious animals. The results of the marking experiment with Yes Bay sockeyes on the Columbia River indicate that between 5 and 10 per cent returns may be expected from 4-inch fish planted in fresh water approximately 150 miles from sea. It seems very unlikely, therefore, that any considerable loss takes place after the fish have migrated, become accustomed to life in the ocean, and reached a size of from 1½ to 10 pounds. Undoubtedly a very high percentage of such fish would survive until fully mature. The taking of these fish before they reach full size is nothing less than sacrificing large future returns for much smaller immediate returns, and, as already shown, the quality of these smaller immediate returns is low.

2. *Waste resulting from the spoiling of fish.*—The poor condition in which many fish taken in the open ocean reach the packing houses has previously been commented on. At the best, this must result in a poorer quality of food and at the worst the salmon becomes so foul that even the most unscrupulous packer will discard them—a total loss. In cleaning the small fish, those below 5 pounds in weight, the butchers usually cut the body just back of the pectoral fins instead of removing merely the head, as is customary in cleaning the larger fish. Although there are no accurate figures bearing on this, the practice must increase the waste due to cleaning from about 25 to 40 per cent.

3. *Waste resulting from the injury of fish hooked but not landed.*—This is undoubtedly much larger than is generally supposed. No data are available, and they would be difficult to obtain. Not infrequently, however, the fishermen report that they have lost as many as they landed. A conservative estimate would perhaps be 2 fish lost for each 10 landed. Fish which have been hooked are frequently taken by gill nets and traps within the Columbia River. Occasionally the hook and spoon is found embedded in the jaws, but more often the jaws are split and badly torn. Many of the fish hooked and lost undoubtedly die, but what percentage is unknown.

The Bureau duly brought this subject to the attention of the fishery officials of the States of California, Oregon, and Washington, and assured them of its desire to assist them in any feasible manner in meeting this menace to the salmon industry. Up to the writing of this report the Bureau has received no request for assistance and is not advised of any remedial measures that have been adopted by the States concerned.

VESSEL FISHERIES OF SEATTLE.

The fishing fleet of Seattle, Wash., landed 834 trips during the year 1918, consisting of 17,091,695 pounds of fresh fish, having a value to the fishermen of $1,887,653, from the fishing grounds along the coasts of Oregon, Washington, and Alaska. The largest quantities were taken from Gray's Harbor Grounds, Flattery Banks, west coast of Vancouver Island, Hecate Strait, and Portlock Bank. The products included halibut, 10,244,200 pounds, valued at $1,528,846; cod, 85,300 pounds, valued at $2,202; sablefish, 4,354,950 pounds, valued at $271,167; "lingcod," 1,784,600 pounds, valued at $62,292; rockfishes, 620,770 pounds, valued at $22,899; and sturgeon, 1,875 pounds, valued at $247. Compared with the previous year, there was an

increase of 214 trips by fishing vessels, and of 2.64 per cent in the quantity and 8.56 per cent in the value of the products. The catch of halibut was not so large as in the previous year, but there was a notable increase in the production of sablefish, "lingcod," and rockfishes.

The fishery products taken in Puget Sound and landed by collecting vessels during the year amounted to 10,605,323 pounds, valued at $912,598. This quantity included 8,929,745 pounds of salmon, valued at $811,028, and the remainder consisted of steelhead, herring, smelt, flounders, sole, crabs, and various other species. Compared with the previous year, there was a decrease in the products landed by collecting vessels of 17.28 per cent in quantity and 7.68 per cent in value.

FISHERIES OF GREAT LAKES, LAKE OF THE WOODS, AND RAINY LAKE.

A canvass of the fisheries of the Great Lakes and certain contiguous waters for the calendar year 1917 was completed by the Bureau during the past fiscal year. The fisheries of the Great Lakes were ascertained to have employed 9,221 persons, the investment was $10,555,669, and the products amounted to 103,759,223 pounds, valued at $6,297,969. The principal species taken, including fresh, salted, and smoked fish, were carp, 7,163,347 pounds, valued at $334,888; ciscoes, 53,429,325 pounds, valued at $2,609,917; "blue pike," 2,102,803 pounds, valued at $140,025; "wall eyed," 2,496,691 pounds, valued at $298,271; sauger, 3,929,172 pounds, valued at $240,035; sheepshead or drum, 2,901,994 pounds, valued at $70,936; suckers, 5,361,138 pounds, valued at $204,825; lake trout, 13,325,389 pounds, valued at $1,285,085; whitefish, 6,190,748 pounds, valued at $723,167; and yellow perch, 4,206,011 pounds, valued at $245,223. With the ciscoes are included lake herring, chub, longjaw, bluefin or blackfin, and tullibee.

Compared with the returns for 1908, published by the Bureau of the Census, there was an increase of 8.06 per cent in the number of persons engaged and of 119.27 per cent in the investment, but a decrease of 2.69 per cent in the quantity with an increase of 67.14 per cent in the value of the products. Compared with the statistics for 1903, collected and published by the Bureau, there was a decrease of 1.20 per cent in the number of persons engaged, an increase of 41.22 per cent in the investment, and an increase of 20.37 per cent in the quantity and 129.39 per cent in the value of the products.

In the fisheries of Lake of the Woods and Rainy Lake, including Lakes Kabetogama and La Croix, 195 persons were engaged; the investment was $177,210; and the products amounted to 2,167,169 pounds, valued at $118,508. The principal species taken were ciscoes, whitefish, pike, pike perch ("wall-eyed pike"), and suckers.

BIOLOGICAL INQUIRY.

STUDY OF FISHES.

Salmon investigations.—There are so many significant questions concerning the habits, migrations, and propagation of the salmons in Pacific States and Alaska that the Bureau has long felt it desirable to attack their solution in a more adequate manner. With the begin-

ning of the last fiscal year a special assistant was engaged for continuous study of the habits of salmon entering streams of the Pacific States. The investigations previously undertaken in Alaska have also been continued. While the investigations in Alaska have been productive of some results which it has been possible to apply with profit in the fish-cultural operations and in the fishery regulations in that section, they must be continued for a further period before results of such definite character are secured as to warrant the publication of a report. The Bureau has now in hand a report presenting the data previously accumulated as bearing upon the migrations and growth of young salmon in the Sacramento and Columbia Rivers.

In the course of the year special biological inquiries were directed to the salmon taken in trolling and purse-seining operations off the coasts of Washington, Oregon, and California. The practical application of the ascertained facts to the regulation of the fishery is elsewhere referred to.

One of the results of the hearings of the American-Canadian Fisheries Conference in Seattle and Vancouver was an arrangement to conduct a joint investigation of the rate of migration of sockeye salmon from salt water into the Fraser River. Early in July, 1918, marking experiments on a large scale were undertaken by representatives of the Bureau of Fisheries and the Canadian Government in cooperation. Although the run of this species was very light that year, more than 4,000 fish were tagged and liberated, and a considerable number of these were subsequently recovered. Results of notable interest and practical importance were obtained and are covered in a report which is in course of publication.

Special interest also attaches to the results gained during this fiscal year from experiments in marking young sockeye salmon planted in the Columbia River in the spring of 1916. At that time about 50,000 yearling sockeyes hatched from eggs received from the Yes Bay (Alaska) hatchery and reared in ponds of the State hatchery at Bonneville, Oreg., were marked and liberated in the Columbia River. Salmon of this species have been found to return in the fourth and fifth years. Many of the marked fish returned during the summer of 1918, the fish being then in the fourth year of life. The marked fish recovered in the Columbia River (being of Alaskan stock) were found to be distinctly different in size and general appearance from the Columbia River bluebacks, representing the identical species, but resembling in every way the fish from the Yes Bay region, where the eggs were taken. Salmon of the Yes Bay type average about 6 pounds, whereas the Columbia River bluebacks this year averaged about 3 pounds. The large size of these fish is particularly significant as indicating that for at least one generation heredity rather than environment determines the size of the fish. This opens prospects for improvement in the quality of the run of fish through carefully conducted cultural operations.

Pilchards on the northwest coast.—During January, February, and March, 1919, a preliminary inquiry was conducted into the occurrence of pilchards on the northwest coast suitable for canning as sardines, especial attention being given to the following localities in Oregon and Washington: Coos Bay and Coquille River, Umpqua River, Yaquina Bay, Alsea Bay, Siletz River, Tillamook Bay, Netarts Bay, Columbia River, Willapa Harbor, and Grays Harbor.

It was learned that somewhat irregular runs of pilchards occur generally along the coast from April to October, especially in the regions of Coos Bay and Umpqua River. While it is believed that the fish are eminently suitable for canning as sardines or otherwise, the Bureau has not felt that the general trade conditions existing in the canning industries justified its giving immediate encouragement to new ventures in the canning of fish on the northwest coast or elsewhere. It is expected that further inquiries and observations may be made at an appropriate season.

The paddlefish.—One of the important fishes of the Mississippi Basin which is diminishing in numbers and seems threatened with extinction is the paddlefish, which is valued to some extent for its flesh but principally for the roe, which is useful for preparation as a relatively high grade of caviar. Up to the present time it has never been possible to secure definite information regarding the breeding habits of this fish. Realizing that a special effort must be directed at this problem before it may become too late, the Bureau, in cooperation with the conservation department of Louisiana, undertook a special study of the breeding habits and propagation of the paddlefish during the latter half of the fiscal year under report. Definite results were were not secured, but it is believed that a groundwork was laid which may contribute toward solution of the problem with further attempts. Meantime it is interesting to record that experiments initiated at the fisheries biological station at Fairport, Iowa, in 1914, have shown that the paddlefish will live and grow for periods of years while inclosed in an artificial body of water such as the storage reservoir of the station.

Spawning of squeteague.—An investigation into the spawning habits and condition of the squeteague in Delaware Bay was conducted in May and June, 1919. It was found that spawning began a little before the middle of May and continued until the middle of June or later. Many fish were examined, townet hauls for the floating eggs were made, and temperatures and salinities were determined.

This body of spawning fish supports an extensive gill-net fishery, which is pursued in small skiffs, the New Jersey law limiting each boat to the use of 50 fathoms of gill net. Experiments were made in the artificial fertilization of eggs from the fish thus taken; this proved to be entirely feasible, and the eggs so fertilized were returned to the water directly on the grounds.

It is evident that it would be productive of good results if the commercial fishermen should become educated to the desirability and advantage of saving the ripe eggs from fish taken for market during this season, fertilizing the eggs and returning them to the water.

FISH IN RELATION TO MOSQUITO CONTROL.

In a previous report mention is made of the practical services rendered by this Bureau in cooperation with the Bureau of Public Health Service in protecting the health of soldiers in Army cantonments. A report of investigation and operations conducted in the vicinity of Camp Hancock has been published conjointly by the two bureaus.

In an effort to determine as precisely as possible the conditions of effective control of mosquitoes by fish, the Bureau has continued

its cooperation with the Bureau of Entomology at Mound, La., where experiments are conducted looking to the improvement of health as regards malaria in rural communities and to the protection of farm labor in the South.

Experiments of like nature are being prosecuted in northern waters where, though mosquito-borne diseases are less prevalent, nevertheless the economic losses attributable to the prevalence of mosquitoes are of great significance.

EXPERIMENTAL FISH CULTURE.

Previous reports have dwelt upon the importance of fish-cultural experiment work and the progress in this field which has been made in connection with fisheries biological station at Fairport, Iowa. The experiments and investigations have continued to show favorable progress, and at the close of the fiscal year the Bureau had taken steps to apply some of the results hitherto gained at Fairport for the improvement of pond fish-cultural operations at several of its regular stations. The field of experimental work in fish culture is so broad, so complex, and so little surveyed, that it is a matter of regret that the means are wanting for the effective prosecution of studies of this character under the very diverse conditions encountered in different parts of the country and with reference to a greater number of species of fish.

SHELLFISH INVESTIGATIONS.

Oysters.—The problems of oyster culture continue to be of such critical importance that the Bureau has been impelled to devote to their solution as great a measure of its resources as could legitimately be applied to one object. While the investigations have not been localized more than was essential for the accomplishment of useful results, the primary seat of activities has been in the vicinity of Milford, Conn., where a temporary field laboratory is maintained for studies of the oyster.

Examination of the waters of this region revealed the fact that a large number, perhaps more than half, of the leased grounds have ceased to be worked because of the small yield of oysters thereon, which is due, in turn, to the general failure of set. The strike of set during the past two years has, in fact, been practically negligible. Consequently, the investigation has been directed primarily toward ascertaining the cause of the failure of the set.

Following suggestions arising from earlier investigations, it was endeavored in 1918 to work out suitable methods for following up the movements of the oyster larvæ with the view of ascertaining just where to place cultch immediately before the time for spatting or setting to occur. The centrifugal machine used during the season of 1917 for separating larvæ from the water was largely superseded this year by a series of screens or sieves of copper-wire cloth of successive stages of fineness from 40 to 200 meshes to the inch. Passing samples of water through the sieves seems to yield as satisfactory results as the centrifuge in separating the oyster larvæ from other objects of different sizes, besides possessing the advantage of roughly classifying the larvæ according to size and age.

The first free-swimming larvæ were found July 16, 1918; the period of greatest abundance was from August 9 to 26, and none was observed after August 30. As the larvæ were found to be free-swimming for a period of about 20 days, it is evident that the bulk of the spawning occurred about August 1. Set was found during the last week in August on most of the beds in water not over 4 or 5 fathoms deep, but practically all of this set died except that which attached in the very early part of the season.

A tentative conclusion drawn from this investigation is that it is of prime importance to secure an early setting, such as results from the spawning of oysters in the shallow and warmer waters of harbors and mouths of rivers. Since it is just such beds that are generally most affected by pollution in the form of sewage and trade wastes, which may be fatal to the life of the free-swimming larvæ, it is evident that the matter of the possible effect of polution on the occurrence of oyster set demands serious consideration. With the cooperation of the water laboratory of the Bureau of Chemistry studies have, therefore, been undertaken with regard to the nature and the effect of the pollutants introduced in the shallow waters.

Further investigations relating to the natural propagation of oysters have been conducted in Great South Bay, Long Island, and Narragansett Bay, R. I.

A very serious condition has manifested itself in oyster beds of a large section of the York River in Virginia, where for several years the oysters have been rendered virtually valueless for market. Examinations of the oysters, begun in November, 1918, revealed the fact that they were affected with a green coloration associated with watery and lean meats. This condition is quite distinct from that known as "green gill" and does not appear to be in all respects of the character of greening which in other localities has been attributed to the storage of copper. No cause has yet been found for the condition observed, which is, perhaps, a very indirect result of disturbance of environmental conditions. The investigation is still in progress, and the Bureau expects to continue it by regular periodic observations for such period of time as may be necessary to arrive at definite conclusions. Since chemical problems are involved, the Bureau has enlisted the cooperation of the water laboratory of the Bureau of Chemistry in the further prosecution of the study.

A poor condition of oysters presented itself, likewise, in Apalachicola Bay during the early winter. After careful investigations were conducted by the Bureau, the condition was attributed to a deficiency of rain in preceding months. At a later time, and after a period of increased rainfall, it was learned that the oysters had fattened and resumed a normal condition.

Late in the fiscal year the Bureau was enabled to undertake at slight expense, by cooperation with the New Jersey State Agricultural Experimental Station, a study of the feeding, growth, and propagation of oysters in the vicinity of Barnegat Bay.

The service of the Bureau to the oyster industry has been rendered more effective by the cooperation extended by several State departments, notably in Connecticut, Maryland, New Jersey, New York, and Rhode Island.

Sea mussels.—The sea mussel is one of the largely unutilized resources of the North Atlantic coast. While it has not been difficult

to create a demand for sea mussels properly prepared, and while some packers have been interested to preserve mussels for market, difficulties have been encountered in obtaining at the right time an adequate supply of mussels in condition for use. During the fiscal year 1918, the Bureau conducted a reconnoissance of the mussel beds of the southern coast of New England and along the shores of Long Island Sound. In the fiscal year 1919 a similar investigation was made on the coast of Maine, with valuable aid from the commission of sea and shore fisheries of Maine. A summary of the results as reported by the investigator may be given:

1. A survey of the mussel beds lying near low-tide level was made between Portland and Eastport. The most important beds were centered in six regions: Casco Bay, Medomak River, St. George River, Deer Isle, Frenchmans Bay, and Jonesport.

2. Within these limits more than 1,200 acres of natural mussel beds were located which were estimated to yield 1,279,000 bushels. Not more than 10 per cent of this area supported a growth of first-class, marketable shellfish. The rest of it was covered with a small, undersized stock of poor quality that would never amount to anything unless transplanted to deeper water and more advantageous situations.

3. The best beds lie at or below low-tide mark and yield from 2,500 to 5,000 bushels per acre.

4. Artificial cultivation, by transplanting young or seed mussels from beds situated between tide marks to areas in deep water, where conditions are favorable for growth and fattening, would result in an enormous production of marketable shellfish.

5. There is no oyster industry on the Maine coast with which a mussel industry might conflict.

6. The water of the bays and estuaries on the Maine coast is unusually pure and free from pollution, which makes them most desirable areas for the production of marketable mussels.

7. There is a small demand for Maine mussels in Chicago which is being supplied from the beds in Frenchmans Bay.

8. Several of the leading packing houses located on the North Atlantic coast are interested in the canning of mussels and are taking steps to put the product on the market. They should be encouraged in this effort by help in solving the problems that arise in the handling and preserving of the shellfish and by advertising any products of real merit that are produced.

9. It is believed that the development of a mussel fishery is a practical thing and that it will add considerably to the wealth and food supply of the Nation.

Fresh-water mussels.—The investigations and experiments bearing upon the propagation of fresh-water mussels, conducted in connection with the fisheries biological station at Fairport, have continued to yield valuable results. One of the most significant experiments was conducted in the Mississippi River at Lake Pepin during the summer of 1918, when fish, after infection with the glochidia of fresh-water mussels, were kept in an inclosure 12 feet square, erected in shallow water in the lake. This small pen was provided with a board bottom over which a thin layer of sand was laid, and after it was placed in water of suitable depth in the lake it was stocked with

172 fish of various species bearing an artificial infection of glochidia of the Lake Pepin mucket (*Lampsilis luteola*). Seventy-nine of the fish were retained in good condition beyond the period of 14 days regarded as necessary for the completion of the stage of parasitism. In all, 11,199 living young Lake Pepin muckets were taken from the pen on September 23 (besides 502 individuals removed on previous dates). This represented an average yield of a little over 80 living mussels per square foot in addition to a few of other species resulting from natural infection. This experiment is of much significance as bearing upon the success of the artificial propagation of the Lake Pepin mucket.

Miscellaneous studies of shellfish.—While it has not been feasible to continue actively the investigations of the blue crab which have been so successfully prosecuted in the fiscal years immediately preceding, the Bureau has completed reports dealing with the blue-crab fishery of the Chesapeake Bay and with the life history of the blue crab. These reports, which were in process of publication at the close of the fiscal year, will undoubtedly be of material value to State authorities concerned with the protection of the crab and the preservation of the fishery in undiminished force. It has been gratifying to learn that a greatly increased catch of blue crabs in these waters has ensued, in consequence, as it is believed, of wise protective measures based in great part upon the results of the Bureau's investigations.

At the Key West, Fla., biological station, inquiries into the habits and growth of the spiny lobster have been continued, and upon the basis of useful information furnished to the State authorities of Florida, more effective protective measures have been enacted into law.

Through the cordial cooperation of the United States National Museum, the Scripps Institution for Research at La Jolla, Calif., and the California Fish and Game Commission the Bureau was enabled, at scant cost, to conduct investigations into the life history of the spiny lobster of the southern coast of California. Results of substantial interest were obtained.

The Bureau also continued, during a portion of the fiscal year, its examination into the shellfish resources of the northwest coast.

AIDING PRODUCTION AND PREVENTING WASTE.

In view of the shortage of food supply which has confronted the country, the Bureau deemed no service more important than that which could be rendered to combat conditions responsible for losses of preserved fish or wastage due to a lack of coordination of supply and demand, in addition to preventing waste of surplus catches of fish and bringing new species of fish into the market. Some of these problems could best be attacked by methods of scientific inquiry, such as the investigation of the preparation of fish by methods of dehydration and the study of methods of preventing the deleterious reddening of salt codfish. In some instances the situation seemed to demand not investigation, but action, and in such cases the scientific personnel of the Bureau was ready and effective for the performance of any service that the situation seemed to require. Consequently, it is proper in connection with the report of scientific investigations to

mention the cooperative services rendered in the campaign for increased consumption of fish from the Gulf of Mexico involving efforts to facilitate capture, transportation, and sale of the fish; the giving of demonstrations and personal instruction in the proper cure of Alaska herring; the partial equipment of an experimental fishery-products laboratory in southern California; and the conduct of experiments in the preservation of fish by methods of canning, salting, and smoking.

While legislation for the protection of fish and shellfish is a function of the several States, it is one of the primary objects of the scientific activities of the Bureau of Fisheries to acquire and distribute such information as will be useful in the framing and enforcement of wise protective laws. Allusion has already been made to assistance afforded the authorities of several States with regard to the protection of the salmon, the blue crab, and the spiny lobster. Cooperation of like nature has been extended in relation to various other fishery resources, notably the fresh-water mussels.

It has been evident for a number of years that the future of the fresh-water mussel industries was largely dependent upon the adoption of proper measures of conservation. An important step in the direction of conservation was taken when, following a series of investigations by the Bureau of Fisheries, Congress authorized the conduct of the artificial propagation of mussels in connection with the establishment of the fisheries biological station at Fairport. The success of artificial propagation, however, is dependent upon the adoption and enforcement of appropriate protective measures, and for this phase of conservation the States alone are responsible. It is not only important that the several States concerned should enforce measures of protection, but, since the mussel resources are frequently found in interstate streams, it is an essential condition of the best results that there should be identical or concurrent legislation among the several States exercising jurisdiction over the different portions of a stream.

Much interest in the matter of concurrent legislation has been manifested not only by the manufacturers of pearl buttons and the mussel fishermen, but by responsible officials of several States as well. The Bureau of Fisheries has also endeavored to cooperate with all interested persons in the devising of protective measures which would be effective in the accomplishment of the desired results without creating greater disturbance of economic conditions than is inevitable. Having been informed that serious efforts were being made in several States of the Mississippi Basin to have protective legislation enacted by the legislatures then in session, the Bureau prepared a statement treating of the necessity for measures of conservation, and this statement was comprised in a paper entitled "Fresh-Water Mussels: A Valuable National Resource Without Sufficient Protection," issued in February and widely distributed in the States concerned.

It seems not inappropriate to direct attention to the fact that the scientific activities of the Bureau have suffered in consequence of the wide disparity between the salaries paid in the Bureau and those paid for work of similar character in other branches of the Government service, and more especially in outside institutions of learning or

research. In consequence of this condition, it is found impossible to keep the lower positions continuously filled, and the effective personnel is always less than the nominal personnel as authorized by the Congress. That a gratifying degree of progress in investigational work has been made during the fiscal year under report is due in great measure to the labors of loyal and self-sacrificing assistants who have devoted themselves permanently or temporarily to national service through the Bureau of Fisheries. It is only fair to them that this statement should be made.

BIOLOGICAL LABORATORIES.

Owing to exceptional conditions none of the Bureau's biological laboratories were in regular and full operation during the fiscal year 1919.

The laboratory at Beaufort, N. C., had been surrendered to the Navy Department for the period of the war, the Bureau having entirely withdrawn except as the experiments in terrapin culture were continued in such manner as to prevent the loss of valuable stock or the interruption of experiments which involved observations and records during periods of several years. At the close of the fiscal year negotiations between the Department of Commerce and the Navy Department were in progress looking to the return of the station to this Bureau.

The Woods Hole (Mass.) laboratory was largely occupied by the Navy Department, and the Bureau had either abandoned temporarily or transferred to other points the investigations normally conducted at this station.

The Fairport (Iowa) biological station was in fuller operation than any other, but since it had been impossible to replace immediately the main building destroyed by fire in December, 1917, the station was operated during the summer of 1918 with a reduced force. Nevertheless, through the loyal cooperation of the permanent personnel of the station and the cheerful submission by temporary investigators to service under conditions of discomfort and inadequate facilities, the progress of the work of the station suffered much less interruption than might have been expected. Some important phases of the work of this station have already been alluded to in connection with various special subjects.

In the early part of the fiscal year advertisements were made soliciting bids for the construction of a fireproof building at Fairport, as authorized by Congress with the appropriation of $80,000 for its construction and equipment. Notwithstanding that the Bureau had made a special effort to reduce the cost of the building as much as possible without sacrificing the essentials of safety and efficiency, the lowest bid received was found to be beyond the available appropriation. Steps were taken immediately to revise the plans, partly by the elimination of some desirable facilities and partly by the most careful attention to such details of construction as might permit a reduction in costs without sacrifice of value. Bids were again solicited during the spring of 1919, but again none was received that came within the amount of the appropriation. It was, therefore, deemed unavoidable that a supplemental estimate be submitted to the Congress. This having been done, an additional appropriation of

$10,000 was made available, and the work of construction is in progress.

At the Key West (Fla.) biological station further progress in construction has been made, and the station is rendering a useful, if as yet somewhat limited, service. The inadequacy of the appropriations granted for the construction and equipment of this laboratory, as well as for its personnel, are matters which will be presented to the Congress in connection with the estimates for the fiscal year 1921. The activities of the station at present have to do with the spiny lobster, with results as indicated on a preceding page, and with the habits, distribution, and propagation of marine fishes.

The Bureau maintains no biological laboratory on the west coast, although it enjoys at times the courtesies of other laboratories existing on that coast. It has also several assistants engaged actively in investigations localized in Pacific Coast States. Since a local headquarters has been found desirable in addition to the office maintained at Seattle, the Bureau has reopened an office in San Francisco. With one resident officer in charge, this office serves a very useful purpose, not only as a headquarters and base of supplies for investigators and other employees, but as an agency for the transaction of local business of the Bureau and for the dissemination of information to the public. Appreciation of the service of this office is attested by the increasing number of persons who call to consult the Bureau's publications, to secure its economic circulars and memoranda, or to solicit information on diverse subjects relating to fish and fisheries.

PROPAGATION AND DISTRIBUTION OF FOOD FISHES.

RÉSUMÉ OF THE OPERATIONS.

The artificial propagation and distribution of food fishes, together with the various collateral activities closely associated therewith, were attended by serious drawbacks in 1919. Difficulty in obtaining and retaining the services of qualified men at the compensation allowed by Congress; the increasing cost of labor, materials, and supplies; and increased charges for the movement of fish-distributing cars, amounting to more than 50 per cent since January 1, 1919, were among the circumstances that combined to retard operations and that compelled most careful planning, efficient execution, and sustained interest and zeal in order to maintain the magnitude and quality of the work without exceeding the funds available.

Nevertheless, the year's output of food and game fishes was larger than ever before. The total number of fishes and fish eggs distributed was about 5,876,985,000, an increase of 718,000,000 over 1917, and about 1,778,000,000 over 1918. Nearly 733,000,000 of fertilized eggs were sent out from the Federal hatcheries; most of these were from the commercial species of the Great Lakes and from Pacific salmons, and nearly all were consigned to State hatcheries, where incubation was completed, the young being planted in local waters. Upward of 440,000,000 eggs of marine fishes were obtained from commercial fishermen of New England, fertilized and planted on the spawning grounds, in addition to the large numbers handled at the hatcheries. Over 4,500,000,000 of young fish were distributed as

fry, mostly lake trout, whitefish, cisco, and pike perch on the Great Lakes; shad, salmon, yellow perch, and striped bass on the coastal rivers; carp and buffalofish in the interior waters; and cod, haddock, pollock, and flounder on the Atlantic seaboard. The output of fingerlings, yearlings, and adults was upward of 151,000,000, with catfish, carp, chinook salmon, sockeye salmon, brook trout, rainbow trout, and crappies predominating. Although the distribution of fish in the fingerling stage decreased about 10 per cent from 1918, this falling off was practically confined to one species and indicates no slackening of effort. On the contrary, facilities for fingerling production are being increased, particularly as regards the salmons of the Pacific coast.

Comparing the general distribution of 1919 and 1918, it may be noted that there was an increase in cisco, rainbow trout, Atlantic salmon, landlocked salmon, buffalofish, carp, shad, pike perch, yellow perch, crappies, pollock, and haddock, and there was a decrease in whitefish, chinook salmon, steelhead salmon, and lake trout.

SUMMARY BY SPECIES OF THE DISTRIBUTION OF FISH AND FISH EGGS DURING THE FISCAL YEAR 1919.

Species.	Eggs.	Fry.	Adults, yearlings, and fingerlings.	Total.
Catfish			12,639,830	12,639,830
Carp		23,699,000	19,754,060	43,453,060
Buffalofish		111,100,000	2,596,335	113,696,335
Shad		84,024,250		84,024,250
Alewife		25,000		25,000
Whitefish	111,650,000	198,715,000		310,365,000
Lake herring (cisco)	146,700,000	86,180,000		232,880,000
Chinook salmon	11,802,500	1,016,600	34,400,150	47,219,250
Sockeye salmon	24,140,100	39,756,000	37,642,220	101,538,320
Silver salmon		7,464,020	2,345,730	9,809,750
Humpback salmon		5,426,500	369,960	5,796,460
Chum salmon		6,253,640	3,663,760	9,917,400
Atlantic salmon		2,390,000	700	2,390,700
Landlocked salmon	405,125	424,870	182,560	1,012,555
Steelhead salmon	805,000	128,125	1,493,290	2,426,415
Rainbow trout	2,939,820	38,500	3,409,190	6,387,510
Blackspotted trout	133,000	200,000	2,875,100	3,208,100
Loch Leven trout			73,000	73,000
Lake trout	3,068,000	28,495,475	765,180	32,328,655
Brook trout	107,000	4,158,050	7,638,615	11,903,665
Grayling		275,000		275,000
Smelt	3,000,000	6,437,000		9,437,000
Pike and pickerel			375,935	375,935
Freshwater drum			18,975	18,975
Crappies			15,837,865	15,837,865
Largemouth black bass		425,045	1,100,420	1,525,465
Smallmouth black bass		195,700	43,745	239,445
Rock bass			75,460	75,460
Warmouth bass			1,060	1,060
Sunfish		3,050	1,350,115	1,353,165
Pike perch	406,200,000	175,550,000	10,710	581,760,710
Yellow perch	22,660,000	179,289,500	2,353,800	204,303,300
White perch		2,035,000		2,035,000
White bass			8,865	8,865
Yellow bass			600	600
Striped bass		13,540,000		13,540,000
Mackerel		9,508,000		9,508,000
Cod	243,870,000	64,331,000		308,201,000
Pollock		703,972,000		703,972,000
Haddock	200,390,000	129,592,000		329,982,000
Winter flounder		2,654,192,000		2,654,192,000
Miscellaneous fishes		1,000,000	747,250	1,747,250
Lobster		7,500,000		7,500,000
Total	1,177,870,545	4,547,340,325	151,774,480	5,876,985,350

HATCHERIES OPERATED.

There has been no addition to the list of regular hatcheries operated. A hatchery provided by the National Park Service of the Department of the Interior was constructed under the supervision of the Bureau in Glacier National Park and is being maintained as an auxiliary of the Bozeman (Mont.) station. Its special function is to maintain and increase the supplies of fish in the various waters of the park. The construction of the hatchery in Rhode Island has been further delayed by the inadequacy of the available appropriation, and Congress will have to provide a substantial addition to the original sum in order that the hatchery and other necessary structures may be completed. The shad hatchery in Maryland near the mouth of the Susquehanna River, whose operations were suspended by order of the Secretary because of failure of the State to conform with the requirements imposed by Congress, has remained closed, and its equipment has been largely transferred to other stations.

The hatchery work as carried on at the 70 main and auxiliary stations in 1919 was located in 33 States and Alaska. The following list, arranged in alphabetical order by States, shows the fish-cultural stations and auxiliaries in operation during 1919, with the fishes handled at each. Mere egg-collecting stations are not included.

Main and Auxiliary Fish-Cultural Stations Operated During the Fiscal Year 1919.

State and locality.	Species handled.
Alaska:	
Afognak	Sockeye and humpback salmons.
Yes Bay	Do.
Arkansas: Mammoth Spring	Largemouth and smallmouth black basses.
California:	
Baird	Chinook salmon.
Battle Creek	Do.
Mill Creek	Do.
Colorado: Leadville	Blackspotted, brook, lake, and rainbow trouts.
Georgia: Cold Springs	Bass, sunfish, catfish.
Idaho: Paris[a]	Whitefish.
Illinois:	
Meredosia	Rescued fishes.
Quincy	Do.
Iowa:	
Fairport	Do.
Manchester	Brook and rainbow trouts, bass, sunfish.
Bellevue	Rescued fishes.
North McGregor	Do.
Kentucky: Louisville	Brook and rainbow trouts, bass, sunfish.
Louisiana: Atchafalaya	Buffalofish.
Maine:	
Boothbay Harbor	Cod, haddock, flounder.
Craig Brook	Atlantic and landlock salmons, brook trout.
Green Lake	Landlocked and steelhead salmons, brook trout, smelt.
Grand Lake Stream	Landlocked salmon
Maryland: Bryans Point	Shad, yellow perch.
Massachusetts:	
Berkshire	Brook and rainbow trouts, smallmouth black bass.
Gloucester	Cod, haddock, pollock, flounder.
Woods Hole	Cod, flounder.
Michigan:	
Northville	Brook and rainbow trouts, smallmouth black bass.
Alpena	Lake trout, whitefish.
Bay City	Pike Perch.
Charlevoix	Lake trout, steelhead salmon, whitefish, pike perch.
Detroit	Pike perch.
Minnesota:	
Duluth	Brook and lake trouts, whitefish, pike perch.
Homer	Black bass, rock bass, rescued fishes.
Mississippi:	
Tupelo	Black bass, crappie, sunfish, warmouth bass.
Friars Point	Rescued fishes.
Missouri: Neosho	Catfish, rainbow trout, black bass, crappie, sunfish.

[a] Auxiliary of the Springville (Utah) hatchery.

MAIN AND AUXILIARY FISH-CULTURAL STATIONS OPERATED DURING THE FISCAL YEAR, 1919—Continued.

State and locality.	Species handled.
Montana::	
Bozeman	Blackspotted, brook, and rainbow trouts, grayling.
Glacier National Park	Blackspotted, brook, and rainbow trouts.
New Hampshire: Nassau	Brook and rainbow trouts, landlocked salmon, smallmouth black bass.
New York: Cape Vincent	Brook and lake trouts, whitefish, cisco, yellow perch.
North Carolina:	
Edenton	Shad, black bass, sunfish, yellow perch, white perch.
Weldon	Striped bass.
Ohio: Put in Bay	Carp, whitefish, pike perch, yellow perch.
Oregon:	
Clackamas	Chinook and steelhead salmons, blackspotted, brook, and rainbow trouts.
Applegate	Chinook, silver, and steelhead salmons.
Rogue River	Chinook, silver, and steelhead salmons, blackspotted and rainbow trouts.
Upper Clackamas	Chinook, silver, and steelhead salmons.
Willamette Falls	Shad.
St. Helens	Do.
South Carolina: Orangeburg	Catfish, black bass, sunfish.
South Dakota: Spearfish	Blackspotted, brook, lake, and Loch Leven trouts, steelhead salmon.
Tennessee: Erwin	Brook and rainbow trouts, black bass, sunfish.
Texas: San Marcos	Black bass, sunfish.
Utah: Springville	Blackspotted, brook, and rainbow trouts.
Vermont:	
St. Johnsbury	Brook, lake, and rainbow trouts, landlocked and steelhead salmons, smallmouth black bass.
Holden	Brook and lake trouts, landlocked and steelhead salmons.
Swanton	Pike perch, yellow perch.
Virginia: Wytheville	Brook and rainbow trouts, black bass, sunfish.
Washington:	
Baker Lake	Chinook and sockeye salmons.
Birdsview	Chinook, chum, humpback, silver, sockeye, and steelhead salmons, blackspotted trout.
Darrington	Chum and silver salmons.
Brinnon	Chum, silver, and steelhead salmons.
Sultan	Chinook, silver, and steelhead salmons.
Quinault	Chinook, silver, and sockeye salmons.
Duckabush	Chum, humpback, and silver salmons.
Quilcene	Chinook, chum, humpback, silver, and steelhead salmons.
Big White Salmon [a]	Chinook salmon.
Little White Salmon [a]	Chinook, chum, and sockeye salmons.
West Virginia: White Sulphur Springs	Brook and rainbow trouts, black bass, sunfish.
Wisconsin: La Crosse	Brook and rainbow trouts, rescued fishes.
Wyoming:	
Saratoga	Blackspotted, brook, and rainbow trouts, steelhead salmon.
Yellowstone National Park [b]	Blackspotted trout.

[a] Auxiliary of the Clackamas (Oreg.) hatchery. [b] Auxiliary of the Bozeman (Mont.) hatchery.

Five special railway cars employed in distributing the output of the hatcheries traveled 97,571 miles, and detached messengers in charge of special shipments of fish traveled 425,966 miles. Distributions were made, as usual, in every State and Alaska

The United States Railroad Administration adopted a new tariff for the movement of fish cars, which went into effect January 1, 1919. The charge for a one-way movement of a car is 10 one-way adult fares, with a minimum charge of $15. This is a material increase over the average rate formerly paid by the Bureau. The United States Railroad Administration also adopted new regulations governing the transportation of live fish in cans and fish eggs in crates in regular baggage service. Effective May 1 in southeastern territory, June 15 in eastern territory, and April 1 in western territory, the baggage tariff was changed to provide for handling not to exceed twenty 10-gallon cans of live fish or 20 crates of fish eggs, or 20 such containers combined.

During the year there were received 8,603 applications for fish for interior waters, most of the applications bearing the indorsement

of a Senator or Representative in Congress. It has been possible to take favorable action on practically all of these applications, the only exception being in the case of the smallmouth black bass, the demand for which is far in excess of the output of the few hatcheries at which this species can be successfully produced.

RELATIONS WITH THE STATES IN FISH CULTURE.

Practical cooperation with the States has continued to prevail throughout the country. In several States egg-collecting stations have been operated jointly, the eggs taken being developed in the hatcheries most conveniently located or from which distribution of the resulting fry could be most advantageously accomplished.

Large numbers of eggs and limited numbers of young fish have been donated to the State fish commissions. This cooperation was extended to 29 States and covered upward of 670,000,000 eggs and over a million young fish, as shown in the following table. On the other hand, various States have made similar donations to the Bureau.

Allotment of Fish and Fish Eggs to State Fish Commissions During the Fiscal Year 1919.

[All figures are for eggs unless otherwise indicated. Fingerlings are designated *a* and fry *b*.]

State and species.	Number.	State and species.	Number.
California: Chinook salmon	11,802,500	New Jersey—Continued.	
Connecticut:		Steelhead salmon	25,000
Catfish	a 1,100	Yellow perch	21,500,000
Crappie	a 3,600	New York:	
Sunfish	a 1,400	Lake trout	1,800,000
Yellow perch	a 1,625	Whitefish	9,000,000
Idaho: Rainbow trout	50,000	Lake herring	32,500,000
Illinois: Whitefish	5,000,000	Landlocked salmon	b 15,000
Indiana: Pike perch	8,050,000	Steelhead salmon	200,000
Iowa:		Strawberry bass	a 100
Rainbow trout	70,000	Sunfish	a 100
Rock bass	a 13,000	Pike perch	60,000,000
Pike perch	5,000,000	Ohio: Whitefish	10,800,000
Kentucky:		Oklahoma:	
Brook trout	a 150	Rainbow trout	a 7,800
Rainbow trout	a 4,250	Black bass, largemouth	a 3,600
Yellow perch	b 100,000	Black bass, smallmouth	a 400
Maine: Landlocked salmon	405,127	Oregon:	
Maryland:		Blackspotted trout	121,000
Rainbow trout	50,000	Rainbow trout	765,000
Rock bass	a 2,900	Sockeye salmon	3,440,100
Sunfish	a 1,415	Pennsylvania:	
Sucker	b 1,000,000	Whitefish	37,070,000
Massachusetts: Pike perch	5,100,000	Lake herring	88,700,000
Michigan:		Pike perch	15,050,000
Lake trout	1,000,000	Rhode Island:	
Whitefish	20,000,000	Black bass, smallmouth	b 7,500
Pike perch	288,800,000	Pike perch	b 200,000
Minnesota:		South Dakota:	
Lake trout	250,000	Brook trout	a 45,000
Rainbow trout	50,000	Rainbow trout	a 50,000
Steelhead salmon	125,000	Tennessee: Rainbow trout	42,700
Black bass	a 6,500	Vermont:	
Missouri: Yellow perch	160,000 b 40,000	Steelhead salmon	50,000
		Pike perch	16,200,000
Montana:		Washington:	
Catfish	a 2,400	Rainbow trout	100,000
Brook trout	a 3,000	Steelhead salmon	230,000
Rainbow trout	1,000,000	Wisconsin:	
Black bass	a 700	Catfish	a 7,200
Crappie	a 1,300	Whitefish	20,000,000
Yellow perch	a 780	Black bass	a 5,000
Nevada: Rainbow trout	25,000	Wyoming:	
New Hampshire:		Rainbow trout	100,000
Rainbow trout	a 2,224	Steehead salmon	50,000
Pike perch	6,000,000	Total	670,716,427 a 165,544 b 1,362,500
New Jersey:			
Rainbow trout	35,000		

PROPAGATION OF COMMERCIAL FISHES OF GREAT LAKES.

While there were many discouraging features connected with the propagation of the commercial fishes of the Great Lakes, the aggregate output of the hatcheries was nearly twice as large as in 1918. Unfavorable weather during the spawning season, together with the scarcity of skilled labor, tended to reduce the numbers of lake trout and whitefish produced, but the poor showing in that branch of the work was in part compensated for by the large increase in the output of cisco and pike perch, the production of which was six times greater than in the preceding year.

For the first time in its history, the Duluth hatchery was stocked with pike-perch eggs collected in State waters, this being made possible through an arrangement with the State authorities for cooperative work at Pike River. The Bureau's share of the operations was 40,000,000 eggs.

A temporary hatchery established at Bay City, Mich., on Saginaw Bay, was equipped with apparatus from other Michigan stations and supplied with water from the city mains for the purpose of utilizing the large number of pike-perch eggs which were reported to be obtainable from the commercial fishermen of that region. The fishermen cooperated to the fullest possible extent in supplying eggs, and the success of the collections far exceeded all expectations. Consignments of eggs from this station were as follows: Two hundred and eighty-eight million eight hundred thousand to the Detroit State hatchery; 60,000,000 to the New York Conservation Commission, and 29,250,000 to the auxiliary hatchery of the Bureau at Charlevoix. The 95,400,000 eggs which were retained at Bay City were lost owing, it is supposed, to chlorine used by the city authorities for clarifying and purifying the water. It is evident that favorable work in pike-perch propagation may be done at this point, and the establishment of a hatchery with a capacity of at least 1,000 jars is desirable. This plant could handle other fish besides pike perch, and there is particular need for artificial propagation addressed to local ciscoes or lake herrings.

In the Lake Michigan and Lake Huron fields covered by the auxiliaries of the Northville station, it was necessary, owing to lack of men, to reduce the number of egg-collecting points formerly operated, which condition, combined with abnormally warm weather and a small run of fish, resulted in the taking of only 33,269,000 lake-trout eggs, less than half the previous year's record. Whitefish eggs for the substation at Charlevoix to the number of 35,548,000 were secured from Lakes Michigan and Huron and were supplemented by shipments of 64,680,000 eggs from Lake Erie, all of poor quality. In the whitefish operations of the Put in Bay hatchery in Lake Erie, 420,650,000 eggs were collected, all but 50,000,000 being obtained from fish taken by commercial fishermen. A considerable proportion of these eggs were consigned to the various State fish commissions, and upward of 126,000,000 vigorous fry were liberated from the Put in Bay hatchery.

The Cape Vincent hatchery had an unusually successful season. For the first time since its establishment, no lake-trout eggs were shipped from other stations, full reliance being placed on home collections. Whitefish eggs to the number of 93,510,000 were secured

from fishermen of Lake Ontario, the great bulk of this take coming from the Canadian side of the lake under an arrangement with the fishery authorities of Canada. The hatchery was overstocked, and consignments of eggs were made to New York, Pennsylvania, and Canadian hatcheries. Fisheries at Fair Haven and Sodus Point yielded 218,000,000 eggs of the cisco, and fisheries in the eastern end of the lake produced additional eggs that brought the total to 239,950,000, of which 146,700,000 were transferred to hatcheries in New York, Pennsylvania, and Canada. The immediate output of the Cape Vincent station was 86,180,000 cisco fry, all planted in Lake Ontario.

In the usual operations on Lake Champlain addressed to the pike perch, 245,350,000 eggs were taken at the newly acquired site near the mouth of Swanton River, and after considerable numbers were shipped to applicants the remainder were incubated at Swanton, yielding 71,500,000 fry which were deposited locally.

An attempt is being made to establish a run of chinook salmon in the St. Lawrence River and Lake Ontario, and to this end chinook salmon eggs in limited number are being sent from the Pacific coast to the Cape Vincent hatchery. The first shipment, consisting of 820,000 eyed eggs from the Little White Salmon hatchery on the Columbia River arrived at Cape Vincent in November, 1918, and 798,400 fry were hatched therefrom. Some of the young reared in troughs took food readily and made splendid growth and had small mortality. The result of this shipment was the planting of 627,000 advanced fry and 150,000 fingerlings.

Mention should be made of the inauguration of whitefish hatching at Bear Lake, situated in Idaho and Utah. A field station, auxiliary to the Springville hatchery, was established at Paris, Idaho, in the autumn of 1918, and several million eggs were secured from fish taken by net fishermen. The experience gained will be valuable in planning for the continuance of this work, which is demanded in order to perpetuate and maintain the whitefish peculiar to this lake.

CULTIVATION OF POND AND RIVER FISHES.

The numerous stations throughout the country that are concerned with the maintenance of the supplies of fish in the rivers and minor waters of the interior have in general been successful in meeting the ever-increasing demands that have been made on them for trouts, basses, and other species.

The demand for brook trout far exceeds the productive capacity of the hatcheries when reliance is placed solely on the eggs obtainable from brood fish and from wild fish in waters available to the various hatcheries. It has, therefore, been necessary to supplement the local collections by considerable numbers of eggs purchased from commercial fish-culturists. During the year 1919 approximately 11,000,000 such eggs were distributed among 15 stations. The other brook-trout eggs that were handled in 1919 consisted of 900,000 collected from wild fish in Vermont, 4,350,000 from wild fish in Colorado, Utah, and Wyoming, and smaller numbers from domesticated fish, the total number from all sources being 16,463,200. The output of 11,903,665 included 7,638,615 distributed as fingerlings. All pending applications for brook trout have been filled by liberal

allotments, and carload shipments have in addition been made to various national forests, the deliveries being to officers of the Forest Service who superintended the planting of the fish.

The demand for rainbow trout is next to that for the brook trout. Considerable collections of eggs have, as usual, been made from domesticated fish held in ponds at the Wytheville, Erwin, White Sulphur Springs, Manchester, and Neosho stations, but the bulk of the eggs—namely, 7,357,100—has come from wild fish in Montana, Wyoming, and Utah. A new and very promising field for collecting eggs of wild rainbow trout has been located in Sage Creek, Wyo., about 70 miles from the Saratoga station. The Madison Valley field in Montana, operated from the Bozeman station, was unusually productive, and 3,935,000 eggs of exceptionally good quality were secured, an increase of nearly a million over the record season of 1918. The collection of grayling eggs in this same locality was the smallest for a number of years.

The landlocked salmon is in great demand in its native State of Maine and in various States to which it is not indigenous. The sources of egg supply in 1919 were Green Lake, Fish River Lakes, and Grand Lake Stream, the number of eggs obtained being 213,000, 914,000, and 345,000, respectively. The first duty of the Bureau as regards landlocked salmon is to maintain the fish in its home waters. As these waters are extensive and many of them are depleted, and as the number of fish available for distribution is limited, many applications from outside States have had to be refused.

The available supply of basses, crappies, sunfishes, etc., has been about the average of recent years. The Mammoth Spring station, the principal source of smallmouth black bass, suffered a serious reduction in output owing to the loss of brood fish by flood. The extension of facilities for black-bass culture is constantly in progress, but the demand can not be adequately met with the existing stations, and an increase in bass stations is needed, particularly in the southwestern section of the country.

In the second season's operations at the temporary field hatchery on the Atchafalaya River in Louisiana, the output of buffalofish was materially increased. From fish caught for market the Bureau's agents, in cooperation with the State department of conservation, were able to save 136,200,000 eggs, from which 110,940,000 fry were hatched. Extremely unfavorable weather interfered with the work and reduced the output.

CARP CULTURE.

Carp culture, discontinued many years ago, has been resumed, as yet on an experimental scale, on Lake Erie in response to a strong local demand from carp fishermen and carp dealers. The western end of the lake is the scene of extensive carp fishing, in connection with which there are maintained large inclosures in which carp are held alive pending shipment to market. The Bureau's operations consist in taking eggs from the fish caught in seines in the Portage River, Ohio, which would otherwise be lost, and hatching them at the Put-in Bay station, the fry being returned to the local waters in which the carp spawn naturally. During the fiscal year 1919 the young carp thus produced and liberated numbered 22,800,000.

Widespread interest in the carp among landowners is evidenced by the large number of applications submitted from all parts of the country for carp for stocking private ponds. In view of the unsuitability of the carp for many waters and the prejudice against it that exists partly because of the mistakes made in the original plantings, the Bureau refers all applications to the fishery authorities of the respective States and defers to their recommendation in acting on applications. Without the State's indorsement the requests for carp are denied.

PROPAGATION OF RIVER FISHES OF ATLANTIC SEABOARD.

Fairly successful results attended the work of the shad hatcheries on the Potomac River and Albemarle Sound, the fry planted numbering 68,558,550, as compared with 39,168,800 in 1918. Most of this output is to be credited to the Bryans Point hatchery, but the Edenton hatchery had a noteworthy increase over all recent years.

The striped-bass hatchery maintained on the Roanoke River as an auxiliary of the Edenton station experienced drawbacks owing to flood water. During the very short spawning season (Apr. 29 to May 11) 17,942,000 eggs were collected; the fry hatched therefrom, numbering 13,540,000, were deposited locally.

In the artificial propagation of the Atlantic salmon, designed primarily to perpetuate the run of that species in the Penobscot River, 870 adult fish were collected in spring and held in pens, and from the 700 survivors at the spawning time 2,613,400 eggs were obtained, the brood fish then being released. The eggs were hatched in 165 days at a mean temperature of 38° F., and the young, numbering 2,390,000, were deposited at suitable points in the Penobscot, Dennys, Pleasant, and Narragaugus Rivers.

At the Bryans Point hatchery the usual excellent results were secured in the propagation of yellow perch. Adult fish that had been caught for market were obtained from fishermen and held in live cars until their eggs were deposited. The fry from this source, all planted in the Potomac and tributaries, numbered 153,679,500.

PACIFIC SALMON OPERATIONS.

Throughout the Pacific States and Alaska the Bureau's salmon-cultural operations in the season 1918–19 were hampered by war activities and by the high cost of materials and the high cost and scarcity of labor. No improvements or repairs at the stations other than those of a minor and pressing character were attempted, and those were done mostly by the regular station force. The untoward conditions were aggravated by the impossibility of maintaining a complete personnel in the statutory positions; at times in certain fields more than 50 per cent of the regular positions were unfilled. A further drawback was the influenza epidemic.

Satisfactory operations were conducted at the two Alaska stations, the collection of eggs of the sockeye salmon at the Afognak hatchery being the largest since the eruption of Mount Katmai in 1912, when all the sockeye salmon inhabiting lakes and streams in the ash belt were destroyed. The take of eggs in these waters has been gradually increasing since 1914, when 7,380,000 were obtained, rising to 54,681,-

000 in 1918, with indications of a still greater improvement during the 1919 season. At the Yes Bay hatchery 47,300,000 sockeye salmon eggs were secured, as against 34,950,000 in the previous season. An innovation in the holding and rearing of young salmon has been inaugurated at Yes Bay by the treatment of the hatchery creek. The water passing through the creek is controlled by a 6-foot gauge, and a 1,000-foot space at the upper end is divided into numerous feeding ponds by placing semicircular rock dams across the stream, while a wire trap has been placed at the lower end of the creek for the capture of Dolly Varden and cutthroat trout, natural enemies of the young salmon in this region. At the lower end of the lake an area of about 4 acres has been screened off and about 6,000,000 young salmon have been placed therein for rearing.

At the various hatcheries in Washington the salmon of all species liberated have aggregated 38,378,285, of which 21,103,025 were fingerlings, while 1,791,000 additional fingerlings were on hand at the end of the fiscal year. At Birdsview, the principal station in the vicinity of Puget Sound, the collections were less extensive than in the previous year, but at Baker Lake the season's outcome was, on the whole, an improvement over several previous years. In continuance of the efforts to establish a run of humpback salmon in the off years, consignment of eggs have been sent from the Alaska stations, and the resulting young have been planted in various tributaries of Puget Sound.

In the Columbia River and throughout the Oregon fields the work at all salmon stations was seriously handicapped by long-continued drought and by the activities of the commercial fishermen, which resulted in the escapement of only a limited number of fish to the spawning grounds. At the Little White Salmon station 10,693,000 chinook-salmon eggs were obtained, and from these 9,177,500 No. 2½ fingerlings were produced. At the Big White Salmon station the egg collections were relatively large, aggregating 10,665,000, the young from which were planted locally as No. 2½ fingerlings.

Salmon hatching in California, at Baird and subsidiary stations, was less expensive than in previous years, owing to low stages of the Sacramento River resulting from a drought. The success of the salmon work in this field is imperiled by the irrigation dam at Redding. No fish are able to pass over this dam excepting, possibly, a few of the early run, which may get over before the slide boards are put in place. No fishway is available, and people living in the vicinity are continually using spears and hooks in the capture of the spawning fish congregated below the dam. The State authorities have promised to install fish ladders, but even with that advantage the future operations are doomed if fishermen are allowed to continue their operations. At the Mill Creek station 17,284,500 chinook-salmon eggs were collected, of which 11,164,500 were shipped when eyed to the State hatchery at Sisson, and 2,304,000 were transferred to Baird. The remaining eggs produced 3,498,800 fingerlings of Nos. 1½ and 2 sizes, all of which were planted in the creek. At Battle Creek, formerly one of the most productive salmon stations on the Pacific coast, only 5,384,000 eggs were obtained. Of these, 638,000 were shipped to the Sisson hatchery, and from the remainder 4,509,000 fry were hatched and reared to the fingerling stage before liberation. No spawn-taking operations were conducted at the Baird hatchery, and there was no

noticeable run of salmon in the McCloud River. The work at this pioneer salmon hatchery was reduced to the care of the eggs shipped from its Mill Creek auxiliary. The output, consisting of 2,280,000 Nos. 1½ and 2 fingerlings, was planted in the McCloud River.

The season of 1918 was one of the most successful for shad production on the Pacific coast. Two field hatcheries operated at Willamette Falls and St. Helens, Oreg., as auxiliaries of the Clackamas station, collected 17,265,000 shad eggs from the fishermen's catch.

CULTIVATION OF MARINE SPECIES.

Marine-fish culture, conducted at the three New England stations—Boothbay Harbor, Me.; Gloucester, Mass.; and Woods Hole, Mass.—was as a whole successful.

Perhaps the most effective branch of this work is that addressed to the winter flounder (Pseudopleuronectes), a species that within a few years has assumed great commercial value in Massachusetts and is now rapidly growing in importance in Maine, giving employment to many persons and yielding good returns at a time when there is little else for the fishermen to do. At Boothbay Harbor egg collections from local waters, especially Linekins Bay, aggregated 1,326,408,000, from which 1,279,256,000 fry were hatched and planted, a very high percentage. At Gloucester, where the catch of gravid flounders was below the average for the past three years, 152,020,000 eggs were taken, and 138,990,000 fry were obtained therefrom, the percentage of hatch being about 91.5. The flounder work at Woods Hole was the most extensive in the history of the station. Most of the eggs, aggregating 1,433,613,000, were obtained from Waquoit Bay fish, but other points on Vineyard Sound and Buzzards Bay yielded considerable numbers, while at a field station established at Wickford, R. I., on Narragansett Bay, 323,238,000 eggs were secured and sent to Woods Hole for incubation. The output was 1,098,130,000 fry and 137,816,000 eyed eggs which latter had to be planted because of the crowded condition of the hatchery.

The hatching of eggs of the shore cod was on such a small scale as to be practically a failure at all stations. There was a fairly large collection of eggs for the Gloucester hatchery, but the low density of the water produced a heavy mortality among the eggs undergoing incubation and made undesirable the sending of other eggs which, to the number of several hundred million, were in consequence deposited on the spawning grounds.

A force of spawn takers working among the Gloucester haddock and pollock fishermen took large numbers of eggs from fish that had been caught for market. Upward of 1,110,470,000 pollock eggs were collected and 702,250,000 fry were hatched and planted. An experimental shipment of pollock eggs from Gloucester to Boothbay Harbor was intended to prepare the way for regular consignments on occasions when the Gloucester hatchery is overflowing. The pollock eggs, arranged on trays surrounded by snow and rockweed, and packed in a field shipping case, arrived in good condition after a 12-hour railway trip and hatched with normal loss. Haddock eggs to the number of 332,740,000 were obtained; 127,190,000 of these had to be planted owing to the low density of the hatchery water, the remainder producing 129,400,000 fry.

The possibility of saving enormous numbers of eggs of marine fishes by placing spawn takers on fishing vessels was experimentally tested in March and April, 1919. Three spawn takers were detailed to accompany fishing craft to Georges Bank with instructions to take eggs from any ripe cod and haddock that might be caught, fertilize, measure, and plant them overboard. As a result of seven trips, 73,200,000 haddock eggs and 58,950,000 cod eggs were thus treated. Two men made four trips on trawl-line vessels and took 32,600,000 haddock eggs and 26,280,000 cod eggs during 46 days. One man spent 30 days on three trips on an otter trawler, and during that time secured, fertilized, and planted 40,600,000 haddock eggs and 32,670,000 cod eggs. The value of work of this nature would seem to depend on the active cooperation of the fishing vessels. If the operations are to be of a magnitude that will make them worth while, a man or several men on each fishing vessel should be assigned the task of fertilizing the eggs of the ripe fish brought aboard the vessel.

LOBSTER HATCHING.

Lobster hatching has practically been abandoned. The Bureau was never able to conduct it on a scale sufficiently extensive to produce any noteworthy effects on the supply, in the face of incessant fishing and a very general disregard for provisions of law affecting egg-bearing and short lobsters.

From the remnant of 8,000,000 lobster eggs carried over from the previous year's operations at the Boothbay Harbor station, 7,500,000 larval lobsters were produced and liberated in local waters in July. At the request of the Maine authorities, 2,000 stripped lobsters which the State had purchased and still owned were held at the Bureau's pound at Pemaquid from the beginning of the fiscal year until September. When the lobsters were collected, it was discovered that a very heavy mortality had resulted, only 624 lobsters being found.

Lobster hatching in recent years was possible only under conditions that violated fundamental principles of business and biology. The Bureau was willing to continue the work year after year in the hope of bringing about a widespread observance of law by affording the fishermen a means of disposing of their berried lobsters and by constantly keeping before the fishermen the need for saving the lobster eggs and immature lobsters. This course, however, could not be indefinitely continued under prevailing conditions, and Congress has now placed such limitations on the expenditure of the fish-cultural appropriation as to make it doubtful whether the lobster hatching can be legally conducted in the existing situation.

The outlook for the lobster from the standpoint of the public is distinctly gloomy in most sections, but the fishermen, as a rule, are well satisfied so long as the present outrageous prices prevail. A recent episode, doubtless typical of numerous communities, serves to indicate how difficult is the task that confronts the State officials. The lobstermen of a certain locality were called together and informed of the desire of the State to secure their support in carrying out the provisions of law for the protection of egg-bearing and short lobsters. The meeting then voted on the proposition, and more than 80 per cent of the lobstermen in the community signified their intention to continue to ignore the law.

The small appropriation made by Congress in an act approved July 1, 1916, for a lobster-rearing plant proved entirely inadequate, even when the capacity of the proposed plant was materially reduced from time to time in an effort to bring it within the appropriation. Request for a supplemental appropriation was not approved by Congress. In these circumstances, the appropriation has been turned back into the Treasury in the expectation that the project may be revived later.

RESCUE OF STRANDED FOOD FISHES.

An outgrowth of the fish-cultural work that has assumed very great value and importance is the salvaging of food fishes from landlocked ponds, pools, and bayous in overflowed districts of the Mississippi valley. These fish, in the natural course of events, are destined to perish and be entirely wasted when the shallow ponds in which they have been left by the receding waters become dry or frozen. During the fiscal year 1919 headquarters for rescue work were established at eight points on the Mississippi extending from Minnesota and Wisconsin to Mississippi and Arkansas; and seining parties from the various fish-cultural stations and the biological station at Fairport covered a wide extent of territory and made collections in excess of those of any previous year. Especially effective work was done from Homer, La Crosse, Bellevue, and North McGregor. When the season closed about December 1, there had been salvaged over 55,000,000 young fishes, representing practically every important species inhabiting those waters, with buffalofish, carp, catfish, crappie, and yellow perch predominating, as shown in the following table:

FISHES RESCUED FROM OVERFLOWED WATERS OF THE MISSISSIPPI VALLEY DURING THE FIRST SIX MONTHS OF THE FISCAL YEAR 1919.

Black bass, largemouth	445,954
Black bass, smallmouth	2,190
Buffalofish	2,590,335
Carp	19,748,562
Catfish	12,607,446
Crappie	15,805,549
Drum	18,977
Pike	375,937
Pike perch	10,710
Rock bass	810
Sunfish	1,065,652
White bass	8,665
Yellow bass	600
Yellow perch	2,354,438
Miscellaneous	747,250
Total	55,783,075

Practically all the fishes thus saved are replanted in the adjacent public waters, but a few are consigned to applicants in various States. In 1919, 55,173,000 fish, more than 98.9 per cent of the total collections, were restored to the Mississippi and tributaries.

Plans have been completed for conducting these operations on a larger scale than heretofore during the fiscal year 1920, and the indications are that the results in 1919 will be more than doubled. The extent of the work that may be accomplished depends mostly on the funds that are available. There are productive fields yet untouched, especially in the central section of the Mississippi valley, and the

saving of these valuable food resources by systematic annual rescue work is of vital importance to the maintenance of the fisheries of the region. The Bureau will expand its efforts to the full limit of financial possibility, and should be reinforced by all the States, some of which up to the present time have exhibited no interest and assumed no responsibility.

SOME NEEDS OF THE FISH-CULTURAL SERVICE.

Among the more urgent needs in the Bureau's fish-cultural work is an increase in the number of hatcheries. The new establishments are desired for States or regions not now provided with hatcheries or only inadequately served by existing hatcheries. In addition to the foregoing, there should be several salmon hatcheries provided for Alaska.

There should be congressional recognition of the invaluable service rendered by the Bureau in salvaging food fishes in the overflowed districts of the Mississippi Basin, and liberal financial provision should be made for its continuance and extension.

Throughout the fish-cultural service there is an underpaid personnel. If the standard of efficiency is to be maintained there must be provided at once a revised salary scale that will retain desirable men and induce others to enter the various grades. Noteworthy results in the artificial propagation of aquatic animals and in the stocking of our interior and coastal waters can not reasonably be expected from a staff that in many cases is changing more quickly than appointment papers can be prepared and delivered.

ARTIFICIAL PROPAGATION OF FRESH-WATER MUSSELS.

The active efforts taken by the Bureau to maintain by artificial means the supply of pearly fresh-water mussels, on which depend important fisheries and an extensive button-making industry, have presented the usual aspects. The work is conducted under the supervision of the fisheries biological laboratory at Fairport, Iowa, at various favorable points in the Mississippi Basin from Arkansas northward.

During the fiscal year 1919 about 136,907,365 young mussels, or glochidia, in a condition of parasitism on fishes, were liberated in public waters as compared with 209,132,825 liberated in the previous year. This decrease was due chiefly to unsatisfactory labor conditions, which made it difficult to keep efficient seining crews steadily employed, with a resulting reduction in the fish catch. The principal reduction was in the Lake Pepin field, the output of which was 35,423,125, as compared with 91,226,800 in 1918.

Four species of commercial mussels were propagated, the leading ones being the common mucket (*Lampsilis ligamentina*) and the Lake Pepin mucket (*Lampsilis luteola*), the others being the yellow sand-shell (*Lampsilis anodontoides*) and the pocketbook (*Lampsilis ventricosa*). The inoculated fish hosts were liberated in the Mississippi River off Fairport, Iowa; in Lake Keokuk, Iowa; at New Boston and Oquawka, Ill.; in the Mississippi River at Lake Pepin, Minn. and Wis.; in Lake Pokegama, Minn.; and in the Black River in the vicinity of Pocahontas and Clover Bend, Ark.

The cost of production during the year was $0.0689 per thousand, practically double that of the previous year. The increased cost was due to the greater cost of labor, equipment, and materials. Overhead charges and an allowance for depreciation amounting to $0.0236 per thousand are included in this computed cost. In connection with this work, 51,600 adult and 653,600 fingerling fishes were reclaimed from landlocked waters in the overflowed lands and liberated in public waters. Of the fishes rescued, 150,949, or approximately 21 per cent, were infected with larval mussels before release.

Experimental plants of adult mussels from the Mississippi River and from Lake Pepin were made in the Roanoke and Shenandoah Rivers in Virginia.

The following table shows the details of the work of artificial propagation:

MUSSEL PROPAGATION 1919, SHOWING NUMBER OF EACH SPECIES PLANTED AND POINTS OF DEPOSIT.

Species.	Lake Pokegama, Minn.	Mississippi River at Lake Pepin, Minn. and Wis.	Mississippi River at Fairport, Iowa.	Mississippi River, at New Boston, Ill.
Yellow sand-shell				193,000
Mucket			15,634,000	10,200,540
Lake Pepin mucket	21,632,100	34,463,300		
Pocketbook		959,825		
Total	21,632,100	35,423,125	15,634,000	10,393,540

Species.	Mississippi River at Oquawka, Ill.	Mississippi River at Lake Keokuk, Iowa and Ill.	Black River, Ark.	Total.
Yellow sand-shell	36,000			229,000
Mucket	20,661,000		14,525,500	61,021,040
Lake Pepin mucket	7,845,000	10,757,100		74,697,500
Pocketbook				959,825
Total	28,542,000	10,757,100	14,525,500	136,907,365

ALASKA FISHERIES SERVICE.

GENERAL CHARACTER OF THE SERVICE.

The duties devolving on the Bureau in connection with the general fisheries of Alaska include the enforcement of law and regulations with regard to the salmon fisheries, the collection of statistics and the dissemination of statistical and other information, the inspection of private salmon hatcheries, the investigation of the aquatic resources, the improvement of the physical condition of salmon streams, the holding of public hearings on proposed regulations for the protection of the salmon supply, and the submittal to the Secretary of Commerce of recommendations embodying modifications of existing regulations.

During the calendar years 1917 and 1918 the Bureau, in cooperation with the Washington-Alaska military cable and telegraph system of the War Department, informally maintained for the benefit of the fishermen of Alaska an intelligence service which covered the towns of Ketchikan, Juneau, Petersburg, Wrangell, Sitka, Skagway, Valdez, Seward, and Cordova. The information thus furnished daily appears to have been of value, and the service met with approval throughout Alaska. Being desirous of extending this work and having it receive official recognition from Congress, the Bureau submitted an estimate for an appropriation of $600 for the establishment in Alaska of a local fishery intelligence agency. The appropriation was not made, the work was not authorized, and the Bureau was criticized for the efforts already put forth.

A comprehensive report on the fisheries of Alaska and the Bureau's activities in relation thereto has been prepared by the chief agent of the Alaska service and has been published as a public document under the title "Alaska Fisheries and Fur Industries in 1918." This report should be consulted by those who desire detailed information.

MAGNITUDE OF THE ALASKAN FISHERIES IN 1918.

When the 1918 season closed, a new record was established in the fisheries of Alaska, for every branch of the industry advanced over the year which had previously shown the highest development, namely, 1917. The following figures for 1918, with comparisons for 1917, show the persons employed, the capital invested, and the value of the product as prepared for market:

Items.	1918	1917	Increase of 1918 over 1917.
Persons employed	31,213	29,491	1,722
Investment	$73,750,789	$54,937,549	$18,813,240
Value of output	$59,154,859	$51,466,980	$7,677,879

It is the salmon industry which gives to the fisheries of Alaska their great importance, and it was the salmon industry that contributed most notably to the increases that occurred in 1918. The value of all salmon products was $53,514,812, of which $51,041,949 represented canned fish to the number of 6,605,835 cases. Thus, 50 years after Alaska became a part of our national domain, the salmon resources alone yielded a product valued at over 7½ times the purchase price of the territory. The 135 salmon canneries in operation were 17 more than in 1917. The changes in apparatus of capture included an increase in pound and trap nets and seines and a decrease in gill nets. The relative importance of the different kinds of gear remained about the same. Seines took 38 per cent of the salmon in southeast Alaska and 39 per cent in central Alaska, but only 4 per cent in western Alaska; pound trap nets are credited with 58 per cent, 48 per cent, and 4 per cent in the respective regions; while gill nets, which took only 2 per cent in southeast Alaska and 11 per cent in central Alaska, took 90 per cent in western Alaska.

The number of salmon taken for commercial use in Alaska in 1918 was 101,454,688, against 92,600,495 in 1917. The red salmon aggre-

gated 35,338,065, and the output decreased 1,158,982; the humpbacks or pinks numbered 48,316,362 and increased 3,441,091; the cohos or silvers numbered 2,911,681 and increased 807,428; the catch of chums, ranking third, amounted to 14,160,818 fish, an increase of 5,633,240; while of the kings, the largest species, 727,762 were taken, an increase of 131,416 over the previous year. The total catch in southeast Alaska was less than in 1917, while both central and western Alaska showed a larger output. Placed end to end, the salmon taken in Alaska in 1918 would extend more than 1½ times around the world at the equator.

Owing to increased attention received during 1918 by the herring, the output of that species took second rank among the fisheries of Alaska, displacing the halibut, which for many years had held that position. The advance was due to a greatly increased pack of pickled herring, in response to the Bureau's efforts to introduce and establish the Scotch cure in Alaska. This stimulus to the herring industry was exhibited also in the much larger quantity of herring pickled after the Norwegian method, which had previously been the only one followed. The year's herring output was valued at $1,819,538, of which amount $748,605 represented Scotch-cured herring.

The Alaska halibut fishery in 1918 was engaged in by 118 steam and gas vessels, and represented an investment of $2,594,292. The catch, amounting to upward of 13,869,000 pounds, valued at $1,667,686, exceeded the 1917 output by 716,000 pounds and $517,000.

The cod fishery has shown but slight fluctuation in recent years. In 1918 the vessel catch in Bering Sea, usually about two-thirds of the total output, was somewhat under that of the previous season, while the catch at the shore stations, chiefly on the southern shore of the Alaska peninsula, was sufficiently increased over 1917 to offset the vessel shortage. The aggregate output of the cod fishery was upward of 14,000,000 pounds, valued at $957,000. Dry-salted fish constituted the bulk of the products, namely, nearly 11,000,000 pounds, with a market value of $778,000.

The only other branch of the Alaska fisheries of prime importance is whaling, which is conducted wholly from shore stations. The number of whales taken was 448, most of which were finbacks; this was 25 more than in 1917. The value of all whale products was $834,000.

FISHERY PATROL.

The patrol maintained by the Bureau during the fishing season of 1918, while by no means adequate or satisfactory, was more effective and comprehensive than ever before. The regular vessels were supplemented by hired craft and the regular force of wardens and agents was augmented by special employees, as far as the funds available would permit.

A detailed statement of the work of the patrol in 1918 in detecting violations of laws and regulations and in prosecuting the offenders in the Alaskan courts is given in the special report on the activities of the Alaska service for that year. There have been numerous convictions, mostly for failure to observe the weekly close season, for setting gear within prohibited distances of other gear, for fishing in closed waters, etc., and substantial fines have been imposed.

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The great need of the Bureau in its task of enforcing laws and regulations for the protection and control of the salmon fisheries of Alaska is larger appropriations for providing additional facilities in men and vessels, so that every important fishing district may be fully covered.

Late in the fiscal year, plans were made to inaugurate a vigorous patrol for the fishing season of 1919, but these for the most part could not be put into effect until the season was well advanced, owing to the failure of the appropriations to become available. Among the new features of the 1919 patrol was the use by the Navy Department, at the solicitation of the Department of Commerce, of submarine chasers in enforcing the fishery laws and regulations, employees of the Alaska service being carried on these vessels.

NEW REGULATIONS FOR SALMON FISHERIES.

Following announcements and hearings in accordance with law, and on the recommendation of the Commissioner of Fisheries, the Secretary of Commerce has promulgated orders providing new regulative measures for the perpetuation of the salmon supply in streams of southeastern Alaska, the Copper River, and the Yukon River. The text of the several orders is as follows:

SOUTHEASTERN ALASKA WATERS. (ORDER PROMULGATED DEC. 21, 1918.)

A hearing having been given at Seattle, Wash., November 25, 1918, after due notice in accordance with law, for the purpose of determining the advisability of making salmon-breeding reserves of certain waters in Alaska, and all persons having had full opportunity to be heard, it is hereby ordered, by virtue of the authority vested in me by section 6 of "An Act for the protection and regulation of the fisheries of Alaska," approved June 26, 1906, that until further notice all fishing for salmon, or other fishing in the prosecution of which salmon are taken or injured, in all hereinafter-described waters of southeastern Alaska east of the longitude of Cape Spencer, be and is hereby made subject to the following limitations and prohibitions in addition to the general restrictions already applicable by virtue of existing laws and regulations:

1. That fishing with all forms of apparatus is prohibited in all streams less than 500 feet in width at the mouth at mean low tide and in all lakes and other waters tributary to such streams.
2. That all fishing with purse seines and drift gill nets and all other movable fishing appliances, other than set nets and beach seines, is prohibited within 200 yards outside the mouth at mean low tide of all streams less than 500 feet in width at their mouth, except at the mouths of the Chilkat and Chilkoot Rivers, where the prohibited distance for all fishing appliances shall be 500 yards.
3. That all fishing with traps, stake nets, and other fixed fishing appliances, and set nets and beach seines is prohibited within 500 yards outside of the mouth at mean low tide of all streams less than 500 feet in width at their mouth. No exceptions will be made in favor of any fixed fishing appliances heretofore operated within the prohibited areas.
4. That the driving of salmon downstream and the causing of salmon to move outside the protected area at the mouth of any stream are expressly prohibited.
5. That this order does not supersede but supplements sections 3 and 4 of the order promulgated by the Secretary of Commerce on November 18, 1912, which, respectively, prohibit all commercial fishing for salmon or other fishing in the prosecution of which salmon are taken or injured "in Anan or Humpback Creek, its lagoon, lakes, and tributary waters, together with the region within 500 yards of the mouth of said creek," and "in Naha stream, its lagoon, lakes, and tributary waters, above a line connecting the points known respectively as Loring Point and House Point." Likewise this order does not supersede but supplements the order promulgated by the Secretary of Commerce on October 25, 1915, which similarly prohibits fishing (*a*) "in all waters tributary to Barnes Lake, Prince of Wales Island," (*b*) "in Hetta Creek, its tributary waters, and the region within 500 yards of the mouth of said creek," and (*c*) "in Sockeye Creek, its tributary Boca de Quadra hatchery waters, and the region within 500 yards of the mouth of said creek."

This order becomes effective January 1, 1919.

COPPER RIVER. (ORDER PROMULGATED DEC. 20, 1918.)

A hearing having been given at Seattle, Wash., November 22, 1918, after due notice in accordance with law, for the purpose of determining the advisability of amending the order of December 29, 1917, effective January 1, 1918, establishing a salmon-breeding reserve and limiting fishing in the Copper River, Alaska, its delta and its tributary waters, and all persons having had full opportunity to be heard, it is hereby ordered, by virtue of the authority vested in me by section 6 of "An Act for the protection and regulation of the fisheries of Alaska," approved June 26, 1906, that until further notice all fishing for salmon or other fishing in the prosecution of which salmon are taken or injured, in the Copper River and its delta and all tributary waters, Alaska, be and is hereby made subject to the following limitations and prohibitions in addition to the general restrictions already applicable by virtue of existing laws and regulations:

1. Commercial fishing is prohibited in waters of the Copper River delta from 6 a. m. on January 1 to 6 a. m. on June 10 of each year, and in the waters of Miles Lake and Abercrombie Canyon from 6 a. m. on January 1 to 6 a. m. on June 15 of each year.

2. Commercial fishing in the waters of the delta shall be limited to set nets and drift gill nets. No such net shall exceed 800 feet in length. The lateral distance interval between all set nets in the waters of the delta herein referred to shall be not less than 600 feet.

3. All fishing is prohibited from the head of the delta to the foot of Miles Lake at all times.

4. All fishing in Miles Lake shall be limited to set nets. No such net shall exceed 800 feet in length, and only one such net shall be extended out from shore from one location. No offshore nets will be permitted in the lake. Throughout the fishing season the shore of the lake shall be considered as it was on June 15. The lateral distance interval between all nets in Miles Lake shall be not less than 600 feet. No fishing will be permitted along the west and north shores of Miles Lake from the north end of Mile 49 bridge to the north end of Miles Glacier, nor along the islands and sand bars between the bridge and the head of the lake.

5. Fishing in Abercrombie Canyon shall be restricted to the use of dip nets operated by hand, such nets not to exceed 16 inches in greatest diameter. No fishing will be permitted at any point on the east side of the canyon or river above the head of the lake.

6. No fishing will be permitted at any time in the waters of the Copper River above Abercrombie Canyon, or in any of the waters tributary thereto, except in the case of local residents who may take limited numbers of salmon for domestic use: *Provided*, That such fishing shall at no time be upon the spawning grounds of any salmon.

7. No net shall be placed in any other than substantially a straight line.

8. For the purposes herein considered, the delta of the Copper River shall be regarded as including all waters south of an east and west line passing through Mile 27 on the Copper River & Northwestern Railway, as at present established, and inside of a line 500 yards off the mouth of each slough and outlet of the Copper River beginning with Alaganik Slough on the west and ending with Gus Wilson Slough on the east, including Pete Dahl, Walhalla, Gus Stevenson, Little King Salmon, Castle, Storey, Big King Salmon (or Copper River proper), Duck, Russian, and all unnamed sloughs between. For the purposes of this order, the mouth of each slough will be regarded as at the edge of the grass banks at the line of mean high tide.

9. The lower end of Miles Lake shall be considered as at the bridge of the Copper River & Northwestern Railway at Mile 49. The head of Miles Lake shall be considered as at the point where the river enters the lake, this point to be as indicated by notices posted by duly authorized representatives of the Bureau of Fisheries.

10. Abercrombie Canyon shall be considered as extending from the head of Miles Lake to Tunnel Point on the Copper River & Northwestern Railway.

11. For the purposes of this order the following definitions are adopted: "Stake net," a gill net attached or affixed to piles or stakes. "Set net," an anchored gill net, one end of which may if desirable be fastened to a stake or other object on shore.

This order becomes effective January 1, 1919, and supersedes the order of December 29, 1917.

YUKON RIVER. (ORDER PROMULGATED DEC. 14, 1918.)

A hearing having been given at Seattle, Wash., November 20, 1918, after due notice in accordance with law, for the purpose of determining the advisability of establishing a salmon-breeding reserve of certain waters in Alaska, and all persons having had full opportunity to be heard, it is hereby ordered, by virtue of the authority vested in me by section 6 of "An Act for the protection and regulation of the fisheries of Alaska," approved June 26, 1906, that until further notice all fishing for salmon or other fishing

in the prosecution of which salmon are taken or injured, in the Yukon River and all tributary waters, and in all waters of its delta to and including the area 500 yards outside each mouth or slough of the delta at mean high tide, be and is hereby made subject to the following limitations and prohibitions in addition to the general restrictions already applicable by virtue of existing laws and regulations:

1. That in 1919, and in each year thereafter unless otherwise ordered in the manner prescribed by law, not to exceed 30,000 cases (48 one-pound cans per case, or the equivalent thereof) of canned salmon, 1,000 barrels (200 pounds net weight each) of pickled or hard-salted salmon, and 200 tierces (800 pounds net weight each) of mild-cured salmon, of all species, shall be prepared for commercial purposes or export; these quantities to be apportioned, after a conference with the local representative of the Bureau of Fisheries, as equitably as practicable among the persons or companies with established plants. Promptly at the end of each calendar week each individual or company shall submit a statement to the said representative of the Bureau of Fisheries showing the number of cases, barrels, and tierces of salmon thus prepared to date, and shall submit also a record of the number of salmon of each species taken daily.
2. That no salmon to be prepared by canning, pickling, or mild curing for shipment from Alaska shall be caught above the junction of the Clear River with the Yukon River near Andreafski.
3. That commercial fishing in the waters of the Yukon delta shall be limited to Kwikluak Pass, commonly known as the south mouth or channel.
4. That the use of traps or pound nets in the Yukon River and its delta is prohibited.
5. That no gill net, seine, or other net used in the Yukon River and its delta shall exceed 700 feet in length.
6. That all commercial fishing, except for local requirements, is prohibited after August 31 of each year.

This order becomes effective January 1, 1919.

PRIVATE SALMON HATCHERIES.

In conformity with law, the two private salmon hatcheries operated by canning companies in southeastern Alaska have been inspected, their methods have been approved, and the issuance of tax rebate certificates has been recommended. The hatcheries on Naha Stream and Quadra Lake liberated 35,057,000 red-salmon fry in the year ending June 30, 1919, and were entitled to remission of taxes to the amount of $14,022.80. A third private hatchery, on Hetta Lake, was not running in the year named.

The conditions under which the private salmon hatcheries were established and have since been allowed a rebate of taxes in proportion to the number of red-salmon fry hatched and planted no longer carry weight. The owners should be relieved of this responsibility, and such hatcheries as may be necessary should be Government owned and operated. The existing hatcheries, if found desirable, should be taken over by the Government at a fair valuation.

COMMERCIAL FISHING IN ALASKAN RESERVATIONS.

During the fiscal year 1919, the Secretary of Commerce, on the recommendation of the Bureau, issued five permits for fishing operations in the Aleutian Islands Reservation, pursuant to the regulations issued jointly by the Departments of Commerce and Agriculture under the terms of the Executive order of March 3, 1913. The number of such permits in force on June 30, 1919, was 24.

In the Afognak Reservation licenses were issued to about 45 natives who desired to engage in commercial salmon fishing. They made a fair catch and had good financial returns owing to the action of the Food Administration in fixing the price of salmon at a higher figure than the natives had ever before received. The number of salmon taken was 126,700, of which 70,790 were humpbacks and

50,660 were sockeyes. Most of the catch was sold to a fishing company at Kodiak. The natives seem satisfied with the Bureau's plan for apportioning the fishing grounds among the fishermen, so that overfishing is prevented and all enjoy an equal opportunity.

ALASKA FISHERY LEGISLATION.

For about eight years legislation affecting the fisheries of Alaska has been pending in Congress. Protracted hearings have been held, and a large amount of testimony and data has been presented to the appropriate committees of the two houses. The necessity for a radical revision of the existing salmon law has been especially pointed out by various agencies and persons interested in the welfare of the fisheries of Alaska, and congressional committees have made favorable reports on bills embodying new legislation.

No new fishery laws have, however, been enacted; and the fisheries of Alaska, at the most critical period of their history, remain subject to laws which have been shown to be obsolete and inadequate. The Bureau of Fisheries is thus placed at a great disadvantage in administering the salmon fisheries of Alaska and can not justly be held accountable for conditions, practices, and developments which, while having the full sanction of law, are not necessarily compatible with the perpetuation of the supply and in some respects are directly opposed thereto.

The law of June 14, 1906, prohibiting aliens from engaging in the fisheries of Alaska, should be amended so as to give full force to its beneficent purpose. The high prices recently commanded by salmon have attracted an unusually large number of persons to the fisheries of Alaska, including many aliens. Instances have come to light where persons who renounced their declaration of intention to become citizens in order to escape the selective draft, and have not since changed their civic status, are claiming or exercising the privilege of operating independently in the fisheries of Alaska, a right that should be restricted to bona fide citizens.

It is the consensus of opinion among persons well informed regarding the halibut fishery conducted off the Alaskan coast that there are wasteful features of the fishery which are imperiling the halibut supply. The situation is difficult to handle, but at least one measure of protection is feasible and meets with general approbation, namely, a close season during several winter months when the fishery is most hazardous, least productive, and most wasteful. This matter was fully considered by the American-Canadian Fishery Conference which held hearings on the Pacific coast in 1918 and recommended remedial legislation which, to be effective, should be uniform in the United States and Canada. This matter should receive the early attention of Congress.

ALASKA FUR-SEAL SERVICE.

OUTLINE OF ACTIVITIES.

In the general administration of the Pribilof Islands, the duties devolving on the Bureau are extremely varied. They comprise (1) the purchase, transportation, and distribution of supplies for the

natives of the seal islands; (2) the transportation of Government employees and natives to and from the islands; (3) the maintenance of schools; (4) the maintenance of a medical staff; (5) the general care of the natives; (6) the handling and investment of funds belonging to the natives; (7) the care of buildings and other Government property; (8) the supervision and protection of the seal herds; (9) the maintenance of a patrol for the protection of the islands against possible raids; (10) the taking, preserving, packing, shipping, and selling of sealskins; (11) the operation of a by-products plant for utilizing seal carcasses; (12) the protection and care of herds of blue foxes, and the taking, shipment, and sale of their pelts; (13) the care, utilization, and improvement of reindeer herds; (14) the construction of roads, the maintenance of proper sanitary conditions, the improvement of landing facilities, etc. The activities in these and other lines are discussed at length in the report entitled "Alaska Fisheries and Fur Industries in 1918," by the chief agent of the Alaska service.

The advance in the cost of practically every article required for the Pribilof Islands has for several years necessitated a reduction in the requisitions to a point that makes impossible the purchasing of any reserve supplies. When, as in 1919, the passage of the bill carrying the appropriation for this service is delayed until midsummer, a serious situation arises from the exhaustion of the stocks of food, medicine, fuel, and clothing. This emphasizes the need for a substantial reserve supply of indispensable commodities, to be used in emergencies, and should give force to the Bureau's appeal to Congress for a small special appropriation for this purpose.

Most of the supplies destined for the Pribilof Islands and the products therefrom were transported on the Bureau's steamer *Roosevelt*, which made two voyages to the islands during the fiscal year. In the spring of 1919 the *Roosevelt* was surveyed with a view to determining necessary repairs. It was found that dry-rot had started in the ship's timbers to such an extent as to make repairs inadvisable. The vessel was accordingly sold at public auction at Seattle on July 15, the sum of $28,000 being realized.

The appropriation of $20,000 that became available on July 1, 1918, for the construction or purchase of a power vessel for the Pribilof Islands proved inadequate, and Congress subsequently provided a supplemental appropriation of $7,500. This has enabled the Bureau to obtain by purchase an acceptable craft, which will be extremely useful.

The increase in the seal herd and in the commercial sealing operations, taken in connection with the important international aspects of the matter, warrant and demand the presence at the islands of an increased personnel competent to deal with the seals in the most efficient manner from the scientific and industrial standpoints. In the estimates of appropriations for the fiscal year beginning July 1, 1920, provision is made for additional members of the staff, including a superintendent, to have general direction and coordinate the administrative affairs of the Pribilof Islands, and a biologist whose continuous studies and observations would be the Bureau's guide in the management of the seals and other animals of the islands. The recent acquisition of means for independent interisland communication at all times makes possible the employment, to better advantage than formerly, of general officials.

CONDITION OF THE FUR-SEAL HERD.

The growth of the seal herd under the conditions now existing is continuous and satisfactory, averaging about 10 per cent annually. The census in recent years has been under the supervision of Dr. G. Dallas Hanna, and represents a vast amount of painstaking field and office work. The methods of the census, the basis for the various computations and estimates, the results, and a discussion of the figures and their significance may be found in the report cited in a special section devoted to the census.

The revised figures of the 1918 census indicated that the seal herd comprised 496,432 animals of all ages as of date of August 10, in addition to 33,881 seals taken for commercial purposes during the year. The unrevised but substantially correct figures of the 1919 census give the full strength of the herd, as of date of August 10, as 524,260 seals of all ages, exclusive of 26,390 taken for commercial purposes during the census year, a net increase of 27,828. The number of pups born in 1919 was 157,172, as against 142,915 in 1918, the respective figures for breeding cows being the same.

The great disproportion in the number of old male seals, arising from the total prohibition of commercial sealing during the period of five years ending in 1917, has occasioned much concern and received special consideration. In the taking of seals, efforts have been directed to the establishment of a proper proportion of breeding animals, through a reduction in the number of old surplus males.

QUOTA AND TAKE OF SEALSKINS.

The 1918 quota of seals to be killed was first fixed at 25,000 and later increased to 35,000. The number actually taken to August 10 was 33,881, 26,881 on St. Paul Island and 7,000 on St. George Island; in addition to which there were taken on St. Paul Island 622, and on St. George 387, a total of 1,009 seals, in the fall of 1918 for the food purposes of the natives.

The quota for 1919 was set tentatively at 35,000 skins, but the number taken through August 10 was only 25,381, of which 22,027 were on St. Paul Island and 3,354 on St. George Island. Seals were present in sufficient numbers easily to meet the quota, but there was a scarcity of labor on the islands owing to the quarantine during the influenza epidemic, which prevented the transportation of additional native workmen from the Aleutian Islands, and also made it impossible for white assistants from St. Louis to reach the Pribilofs. Furthermore, there was much additional labor involved in taking and handling the skins of the larger surplus seals whose utilization is demanded. These circumstances reduced the number of skins that could have been taken under normal working conditions.

FOXES AND REINDEER.

The blue foxes of the Pribilof Islands are regarded as having fur of better quality than those from any other region. They are trapped, under careful supervision, during a short period in winter, the natives being paid $5 apiece for each fox skin secured. The foxes on St. George Island are more numerous and in better physical condition than on St. Paul Island. In the winter of 1918–19 trap-

ping was conducted for five days in December on St. Paul Island, and 119 blue-fox and 25 white-fox pelts were obtained. On St. George Island trapping was done during parts of December, January, and February, and 548 blue and 5 white pelts were taken. Efforts are being directed to the improvement of the breed of foxes on St. Paul Island.

The reindeer, of which 40 were introduced on the Pribilofs in 1911, have flourished and increased, and the surplus males are now furnishing a limited amount of fresh meat. It is believed that in a short time, with the present rate of increase, these animals will become a much more important factor in the food supply. In the summer of 1918 there were on St. Paul Island 160 reindeer, including 40 fawns, while St. George Island reported 114 reindeer of all ages at the end of the calendar year. Twenty animals were used for food on both islands in 1918.

RECEIPTS FROM SALE OF PRODUCTS.

During the calendar year 1918 two public auction sales of fur-seal skins were held at St. Louis by Funsten Bros. & Co., agents of the Government. The skins, numbering 8,100 and representing seals taken during 1917, were offered in a dressed, dyed, and machined condition, ready to be made into garments; the gross price received was $375,385, an average of $46.34 per skin. The net proceeds were $257,333.21. A feature of each sale was a small lot of "wigs"—skins of the largest size, taken from old bulls—which brought the highest prices, although in former years, when "wigs" were disposed of abroad in a raw state, they were in little demand and were sold at only $6 to $10. The demonstration by Funsten Bros. & Co. that the skins of old bulls have an excellent fur and that they can be made available for all the purposes for which the pelts of younger males are used is one of the most interesting and important developments of the American sealskin industry.

In the calendar year 1919 there have been two auction sales of sealskins taken in the previous calendar year. The skins numbered 15,275, and the net proceeds therefrom amounted to $1,026,728.84. At the last sale, held in September, the average price of sealskins was $91.35, an advance of 30 per cent over the first sale, in April. The estimated net value of all the seals taken in 1918, allowing for the unsold skins at the prices received at the September sale, is $2,467,334.45.

The fox pelts resulting from the previous season's trapping were sold at public auction in St. Louis on October 7, 1918. They numbered 692 blues and 19 whites, and brought $57,099.50 and $1,080, respectively, gross, and $51,898.64 net for the two grades. The average gross price for blues was $82.51. The fox pelts taken during the fiscal year 1919 were sold on September 10, 1919, and brought the highest prices ever obtained, averaging $195.90 for blues, an advance of 135 per cent over the previous year's sale. The approximate net revenue from this sale is $123,285.

The seal-island natives have been encouraged to collect old seal bones when their other duties permit, and are paid for such collections. During 1918 they obtained about 300,000 pounds, which were shipped to Seattle and San Francisco on Government vessels and sold under contract, netting $3,891.03.

MINOR FUR-BEARING ANIMALS OF ALASKA.

COMMERCIAL VALUE OF THE MINOR FUR BEARERS.

The Bureau collects statistics of the furs shipped out of Alaska each year, using for this purpose special blanks that are supplied to postmasters, express offices, commercial companies, and individual shippers. Postmasters have cooperated effectively in securing full reports on all mail shipments, and the customhouse records are available for checking up other shipments.

The quantities of furs sent out of Alaska in 1918 were in excess of the records for previous years, with the exception of lynxes and foxes and their value surpassed all other seasons. The compiled figures, exclusive of the fur seals taken on the Pribilof Islands, indicate $1,363,600 as the value of the furs shipped out of Alaska. Most important of the fur bearers were red fox, worth $342,496; white fox, $181,240; lynx, $199,992; mink, $159,718; and muskrat, $103,948.

Fur farming is receiving much attention in Alaska, but the results, as a whole, are not very satisfactory. The Bureau has had reports of many more or less unsuccessful ventures. Foxes are the favorite animals handled, with occasionally martens, minks, and muskrats. At the end of the calendar year 1918 three islands under the jurisdiction of the Department were under lease for the propagation of fur-bearing animals. A number of other islands are available for this purpose.

REGULATIONS AND VIOLATIONS.

The 1917 regulations for the taking of fur-bearing animals were substantially unchanged for 1918. The period of total prohibition of beaver trapping was extended to November 1, 1923. On the recommendation of the Governor of Alaska and other disinterested persons, the open season for taking foxes in the region draining into the Arctic Ocean north of the sixty-eighth parallel was extended 30 days, so as to include April 14. On September 18, 1918, there was issued a new order prohibiting the use of dogs in pursuing or killing any fur-bearing animals for which a close season is prescribed.

There have been various prosecutions and seizures of furs for violation of the regulations for the protection of fur-bearing animals. The principal infractions of the regulations are sale of unprime skins obviously taken out of season and possession or sale of beaver, marten, and fur-seal skins. The confiscated furs have been disposed of at public auction in Seattle, and have yielded several thousand dollars in revenue to the Government.

TRANSFER OF CONTROL.

The Bureau is administering to the best of its ability the laws relating to the terrestrial and arboreal fur bearers of Alaska, but the duty is incongruous to its legitimate functions. The pursuit of foxes does not constitute a fishery. The cultivation of minks can not be successfully conducted in a fish hatchery. If Congress desires to retain jurisdiction over these animals, control should be vested in the Bureau of Biological Survey of the Department of Agriculture. The proper alternative course would be to transfer the jurisdiction to the Territory.

MISCELLANEOUS MATTERS.

APPROPRIATIONS AND ALLOTMENTS.

The appropriations for the Bureau of Fisheries for the fiscal year 1919 aggregated $1,183,140, as follows:

Salaries	$437,940
Miscellaneous expenses:	
Administration	10,000
Propagation of food fishes	400,000
Maintenance of vessels	95,000
Inquiry respecting food fishes	50,000
Statistical inquiry	7,500
Protecting sponge fisheries	3,000
Protecting seal and salmon fisheries of Alaska (including deficiency of $44,700)	144,700
Improvements at the Berkshire (Mass.) trout hatchery	2,500
Establishment of an auxiliary hatchery, Lake Champlain	5,000
Vessel for Pribilof Islands (including deficiency of $7,500)	27,500

A detailed statement of the expenditures under the regular and deficiency appropriations will be submitted in accordance with law.

Three allotments from the appropriation for the national security and defense were made by the President during the year, as follows: On July 2, 1918, $125,000 for a fishery-products laboratory in Washington, D. C.; on July 2, 1918, $25,000 for increasing the food-fish supply; and on January 11, 1919, $10,000 for the same purpose.

VESSEL SERVICE.

The steamer *Roosevelt* reached Seattle on July 7, 1918, from the Pribilof Islands and at once made ready for another trip, taking on a miscellaneous cargo of general supplies, lumber, machinery, salt, coal, etc. Departure was made July 26, and the vessel arrived at Unalaska August 21, where she took on additional fuel and a shipment of salt which had been sent by commercial freight to that place. Two additional round trips between the island and Unalaska were made to transport the freight stored there. On the return voyage a large shipment of sealskins and a quantity of old bones were carried from St. Paul Island. Bad weather was encountered which prevented the bringing out of any products from St. George Island. The vessel reached Seattle at midnight, October 3. On her next voyage the *Roosevelt* left Seattle October 15, and arrived at the islands November 3. The landing of cargo was delayed by storms, and it was necessary to go to Akutan for additional fuel before discharging all freight. Final departure from the islands was made on December 12, the vessel reaching Seattle with a cargo of sealskins, bones, etc., on January 3, 1919.

On January 17 the master of the *Roosevelt* reported the vessel to be in need of overhauling, refitting, and repairs to put her in seaworthy condition, and this report was confirmed by officers in the Steamboat-Inspection Service who surveyed the vessel. Arrangements were made to have the required work done at the Bremerton Navy Yard, but an examination of the ship by construction officers of the Navy elicited the report that repairs amounting practically to rebuilding would be necessary to put her in satisfactory condition and that

the cost and time involved would not be justified. Accordingly, on June 4 the *Roosevelt* was condemned and after the customary advertising was sold at public auction to the highest bidder on July 15, 1919, for $28,000.

Four vessels of the Bureau which were placed at the disposal of the Navy Department for the period of the war have been returned in good condition. It is understood that the military services of all, as part of the auxiliary fleet, were important and useful. The *Albatross* was under naval control from November 19, 1917, to June 23, 1919; the *Fish Hawk* from July 18, 1918, to July 1, 1919; the *Halcyon* from May 14, 1917, to August 5, 1919; and the *Phalarope* from December 6, 1917, to July 29, 1919. Both the *Fish Hawk* and the *Phalarope* were employed in Navy work for considerable periods prior to their being formally taken over.

With the special appropriation for a vessel for the Pribilof Islands, the power schooner *Eider* was purchased at Seattle for $26,500. This boat, formerly a deep-sea halibut vessel known as the *Idaho*, was built in 1913 and is of particularly seaworthy construction. She is 88 feet long, and 19 feet beam, and is equipped with a 110-horsepower Frisco standard engine with the usual auxiliary machinery and fuel tanks of sufficient capacity to give a cruising radius of 5,500 miles. She will be further equipped with wireless apparatus, and as part of her duty will be guarding the fur-seal rookeries, she will be furnished with a light gun.

There have been transferred to the Bureau by the Navy Department the motor boats *Enterprise* (S. P. 790), *Polly* (S. P. 690), *Cobra* (S. P. 626), and *Calypso* (S. P. 632). The two former will be used in fish-cultural work on the Maine coast, and at Cape Vincent, N. Y., respectively, and the two latter as patrol boats in southeast Alaskan waters.

COOPERATION WITH OTHER GOVERNMENT AGENCIES.

The Bureau of Fisheries cooperates with numerous other Government bureaus, and is glad to acknowledge the helpful attitude which exists throughout the public service.

Relations of public importance have been maintained with the National Park Service, Department of the Interior, in Yellowstone and Glacier National Parks, where the Bureau conducts hatcheries and supplies fish for the stocking of park waters, while the National Park Service affords various facilities to this end. Shipments of fish are made to other national parks on the request of the proper officials. The attraction which the national parks have for the general public is increased by the angling facilities they afford; and the Bureau is in cordial accord with the movement to secure larger patronage for our unrivaled national recreation grounds.

The Bureau of Indian Affairs has entered into an agreement with the Bureau to promulgate better fishing regulations on the Quinault River in Washington, where a salmon hatchery is maintained for the benefit of the Indians. It became necessary to revise the regulations governing fishing by the Indians, and this was successfully accomplished after many conferences between officials of both bureaus.

The Reclamation Service has tendered assistance in planting fish in streams and reservoirs that come under its control, and has published articles prepared by the Bureau in regard to the stocking of waters.

The Forest Service has taken the greatest interest in the stocking of streams in forest reservations throughout the country. Its district forest supervisors have been receiving fish at the railroad stations and taking them back into mountain streams, by pack horse in many instances, in especially constructed cans belonging to the Forest Service. This work has extended throughout the Rocky Mountain region, to Minnesota and Wisconsin, to the White Mountains, and to the Alleghanies in North Carolina. The fish thus handled by the Forest Service are placed in mountain streams and such waters as are heavily fished by tourists, thus affording much pleasure to a large and appreciative public. The increased use of automobiles by touring parties, and the movement to construct good roads through the forest reservations are causing more people to seek the reservations each year, and angling is one of the principal attractions.

With the Bureau of Chemistry the Bureau has cooperated in the examination of various fishery foods, with reference to the correctness of labels and the suitability for human consumption. The two bureaus worked together in introducing half a million pounds of Gulf fish into interior markets.

The States Relations Service South of the Department of Agriculture and the Bureau of Fisheries have cooperated effectively in various ways, the principal one being in giving demonstrations of the methods of preparing and cooking fish; these demonstrations being at points in Florida, Mississippi, Georgia, and in Washington, D. C.

The Bureau of Animal Industry has cooperated with this Bureau in bringing about an increased production of fish meal and calling the attention of agriculturists to the value of this product as animal food. The part taken by the Bureau of Fisheries has been to interest persons in the fishery industries in the production of this product, while the Bureau of Animal Industry carries on feeding tests and finds markets for such material as is produced.

Reference is made elsewhere to the work of the Bureau, undertaken in connection with the Public Health Service, in eradicating mosquitoes in the extra-catonment zone at Camp Hancock, Ga. Experiments in mosquito control are being jointly conducted by the Bureau of Entomology and the Bureau of Fisheries in Louisiana.

The Coast Guard has rendered invaluable service, as heretofore, in connection with the Alaska work of the Bureau, more particularly with regard to transportation of persons and supplies to the Pribilof Islands.

In October, 1918, the Coast Guard cutter *Bear* made a special trip to Seattle for the purpose of bringing out Assistant Agent A. C. Reynolds for urgent medical treatment. A small shipment of fur-seal skins from St. George Island was also carried. In response to a request from the Secretary of Commerce, on February 12, 1919, the Secretary of the Navy advised on March 3 that the commodore commandant of the Coast Guard had been directed to detail the cutters *Unalga* and *Bear* to maintain the usual patrol for the protection of the seal herd. The *Bear* sailed from Seattle on May 14

and carried as passengers for the Bureau four employees from the plant of Funsten Bros. & Co., who were to assist in the sealing work on the islands. A small quantity of emergency supplies also was transported. Because of the quarantine established on account of the epidemic of influenza, these passengers could not be landed at the islands by the *Bear* and were taken to Nome and subsequently returned to Seattle.

The Fuel Administration issued orders making it imperative that the Bureau's stations and distribution cars be supplied with coal in such quantities and at such times as might be required. Had this not been done many of the stations would have been compelled to shut down, and the car service would have been crippled in its efforts to distribute fish.

The Food Administration and the Bureau together worked out regulations governing fishing during the war period, and cooperated in other ways.

Respectfully submitted.

H. M. Smith,
Commissioner of Fisheries.

To Hon. William C. Redfield,
Secretary of Commerce.

DISTRIBUTION OF FISH AND FISH EGGS DURING THE FISCAL YEAR 1919

GLEN C. LEACH
Assistant in Charge of Fish Culture

Appendix I to the Report of the U. S. Commissioner of Fisheries for 1919

CONTENTS.

INDEX TO SPECIES DISTRIBUTED.

[a] Distributed as crappie.

DISTRIBUTION OF FISH AND FISH EGGS DURING THE FISCAL YEAR 1919.

DESCRIPTION OF WORK.

EXTENT AND CHARACTER OF OPERATIONS.

During the fiscal year 1919 the Bureau of Fisheries produced at its fish-cultural stations 5,876,985,350 fish and fish eggs and disseminated them throughout the country, its distributions embracing every section of the United States and the coastal regions of Alaska.

Approximately 95 per cent of this output consisted, as heretofore, of the salmons, shad, whitefish, pike perch, yellow perch, lake trout, cod, pollock, haddock, and winter flounder, which constitute the more important commercial species; all of which fishes were planted by the Bureau either on or adjacent to the spawning grounds from which the eggs originated or in nonproductive waters where the natural conditions appear to favor the development of new and profitable fisheries.

Though relatively small in numbers of fishes produced, that branch of the work pertaining to the production of fishes suitable for stocking interior waters is in reality a very important part of the Bureau's activities. Aside from its economic value, which is large and is constantly increasing, its prosecution necessarily involves contact and cooperation with the general public, thus serving to arouse and stimulate an interest in the fisheries which can not be other than beneficial in its effect. Among the fishes most extensively propagated for stocking ponds, lakes, and streams, both public and private, are the various trouts—brook, rainbow, and blackspotted—the largemouth and smallmouth black bass, rock bass, sunfish, crappie, and catfish. Various other species are also handled in limited numbers.

While the output of the pondfish cultural stations is annually expanding, it is far from being sufficient to meet public requirements. The deficiency is made up to some extent from the collections of young food fishes which are found in large numbers in the temporary lagoons existing during certain seasons of the year in the high-water zones along the Mississippi River and some of its tributaries. Early in the year these rivers overflow their banks and spread out over miles of territory, and in the warm shallows thus formed many varieties of native food and game fishes deposit their spawn. With the subsidence of the floods the young fishes resulting from such spawn are imprisoned in the thousands of depressions existing, at depths ranging from a few inches to several feet. Here they are exposed for several months to the depredations of game birds and aquatic enemies and, if not removed, all of them finally perish with the drying and freezing of the pools. The great bulk of the immense numbers of fishes

which the Bureau annually rescues from these temporary waters is returned to the original streams, but a small percentage is used to supplement stock for distribution to applicants, and it is only in this way that the heavy demands for pondfishes can be met.

This work of conserving fish life in the Mississippi River Valley, instituted on a small scale by the Federal fishery department many years ago, has been gradually expanded as facilities permitted, so that during the fiscal year 1919 the results of such operations aggregated 55,818,817 fish rescued, of which all but 610,021 were returned to their native waters. This latter comparatively small number was transported for distribution in other sections of the United States by means of the Bureau's distribution cars.

Inquiries recently instituted by the Bureau show that remarkable success is being attained in the stocking of interior waters with fish furnished from its stations. Most of the reports received on this branch of the work are favorable, but the results in the case of farm ponds are especially encouraging. Thousands of such ponds, though formerly destitute of fish life, are now claimed by the owners to be yielding an abundant supply.

ASSIGNMENT OF FISHES TO APPLICANTS.

On receipt of a request for fish, the Bureau supplies a blank calling for a complete description of the waters to be stocked, and when the application is submitted the information contained therein is used as a basis for determining the species to be assigned.

SELECTION OF SPECIES.

The experience of the Bureau has demonstrated that in nearly every case it is preferable to introduce a species native to the locality of the waters to be stocked, and in specifying his choice of fish the applicant should bear this in mind. Nonindigenous fishes are furnished only upon the recommendation of his State fishery authorities, and, even with such indorsement, the Bureau reserves the right to exercise its judgment in the matter.

Predacious fishes like black bass and perch are not suitable for waters inhabited by trout, and the Bureau refuses to entertain applications for these or any of the other spiny-rayed fishes for introduction into waters in Idaho, Washington, Oregon, California, or the western portions of Montana and Wyoming, believing that their presence in such waters might prove harmful to the important salmon and trout fisheries of those States. Species belonging to the Salmonidæ are not supplied for waters which already contain fishes that are known to prey upon them. In order to obtain carp for a private pond or lake, an applicant must first secure the indorsement of his State fishery authorities and must satisfy the Bureau that there is no way for them to escape into public waters. The right is also reserved to substitute a more desirable food and game species in place of the carp if the description of the waters named in the application indicates that they are suitable therefor.

Eggs of certain species of fish are furnished to State hatcheries on request and occasionally to applicants who have hatching facilities, with the understanding that the product will be deposited in public waters.

SIZE OF ALLOTMENTS.

In planning for its distributions the waters from which the Bureau's egg collections are obtained must have first consideration. After such provision has been made the remainder of the available stock is allotted to applicants for stocking public or private waters.

In determining the size of allotments to be made on applications the Bureau is governed by the number and size of the requested species available for distribution, by the extent of the water area to be stocked, and by the distance to which the fish must be transported. In every case the Bureau aims to supply only a sufficient number of young fish for the establishment of a brood stock, and it is expected that the recipient will take steps for their protection until they have had time to mature and stock the waters through natural reproduction.

TIME AND METHOD OF DELIVERY.

Certain species, notably the brook trout and rainbow trout, are planted whenever possible during the fingerling stage; but, as the rearing facilities are limited, the stock must be reduced in the early spring to prevent overcrowding. Thus a part of the output is annually shipped in the fry stage. The distribution of the basses and other pondfishes begins about three weeks after they are hatched, and extends over a period of several months, the last lots of fish sent out ranging from 2 to 4 inches in length. The basses, sunfishes, crappie, yellow perch, and other fishes rescued from landlocked ponds and pools in the Mississippi River Valley are from 3 to 6 inches long when distributed.

It is the policy of the Bureau to fill applications in the order of their receipt and to deliver the fish assigned as soon thereafter as possible, but there are certain conditions connected with the distribution work which should be thoroughly understood by prospective applicants.

The cost involved in making shipments of fish compels the Bureau to exercise the utmost economy in arranging its distribution work. The delivery of special consignments and those intended for distant points must be delayed until a sufficient number of applications from the same section of the country have been received to warrant the expense of a messenger shipment. The Bureau can not carry a stock of fish for delivery on demand, and when the supply of one year is exhausted no more are available until the crop of the succeeding year is ready to be sent out. The shipment of trout from the Bureau's eastern stations begins early in March, and all applications received after that time are carried over until the following year. Trout distributions from stations in the Rocky Mountain regions are made between May and October, and, in order to insure early attention, applications from that part of the country should be in the Washington office of the Bureau not later than May 1. The so-called warm-water fishes, including black bass, sunfish, and crappie, are shipped between May and December, and requests for them should be submitted prior to May 1.

The fish are shipped in railroad cars especially designed for the purpose or in baggage cars, accompanied by a messenger, and the delivery is made at the applicant's railroad station without expense to him. When an application for fish is received by the Bureau the

person submitting it is immediately notified of the species assigned thereon and the approximate time when delivery may be expected. Full directions for the reception and care of the fish are also sent to him. Prior to the shipment a second notice is sent, usually a telegram, specifying the exact time when the assignment will arrive at his railroad station. In the event that for some unforseen reason it becomes necessary to postpone the delivery the applicant is notified accordingly.

CHARACTER AND SIZE OF OUTPUT.

During the fiscal year 1919 the Bureau propagated and distributed some 60 species of fish and lobster, as shown in the following list. Fishes rescued from overflowed lands in the Mississippi Basin and restored to original waters or distributed in other sections of the United States are included.

List of Species Handled.

The catfishes (Siluridæ):
- Horned pout, bullhead (*Ameiurus nebulosus*).
- Marbled catfish (*Ameiurus nebulosus marmoratus*).
- Mississippi catfish (*Ameiurus lacustris*).
- Spotted catfish, channel catfish (*Ictalurus punctatus*).
- Yellow catfish (*Leptops olivaris*).

The suckers (Catostomidæ):
- Mongrel buffalofish (*Ictiobus urus*).
- Common buffalofish (*Ictiobus cyprinella*).
- Smallmouth buffalofish (*Ictiobus bubalus*).
- Common sucker, white sucker (*Catostomus commersonii*).
- Common red horse, mullet (*Moxostoma aureolum*).
- Black sucker (*Hypentelium nigricans*).

The carps (Cyprinidæ):
- Asiatic carp (*Cyprinus carpio*).

The shads and herrings (Clupeidæ):
- Shad (*Alosa sapidissima*).
- Alewife (*Pomolobus pseudoharengus*).
- Skipjack (*Pomolobus chrysochloris*).

The salmons, trouts, whitefishes, etc. (Salmonidæ):
- Common whitefishes (*Coregonus albus* and *C. clupeaformis*).
- Lake herring, cisco (chiefly *Leucichthys artedi*).
- Chinook salmon, king salmon, quinnat salmon (*Oncorhynchus tschawytscha*).
- Silver salmon, coho (*Oncorhynchus kisutch*).
- Humpback salmon (*Oncorhynchus gorbuscha*).
- Chum salmon (*Oncorhynchus keta*).
- Blueback salmon, redfish, sockeye (*Oncorhynchus nerka*).
- Steelhead salmon (*Salmo gairdneri*).
- Rainbow trout (*Salmo shasta*).
- Atlantic salmon (*Salmo salar*).
- Landlocked salmon (*Salmo sebago*).
- Blackspotted trout, redthroat trout (*Salmo lewisi*).
- Loch Leven trout (*Salmo levenensis*).
- Lake trout, Mackinaw trout (*Cristivomer namaycush*).
- Brook trout (*Salvelinus fontinalis*).

The graylings (Thymallidæ):
- Montana grayling (*Thymallus montanus*).

The smelts (Osmeridæ):
- Smelt (*Osmerus mordax*).

The mackerels (Scombridæ):
- Common mackerel (*Scomber scombrus*).

The sunfishes, black basses, and crappies (Centrarchidæ):
- Crappie (*Pomoxis annularis*).
- Strawberry bass (*Pomoxis sparoides*).
- Rock bass (*Ambloplites rupestris*).
- Smallmouth black bass (*Micropterus dolomieu*).
- Largemouth black bass (*Micropterus salmoides*).

THE SUNFISHES, BLACK BASSES, AND CRAPPIES (CENTRARCHIDÆ)—Continued.
- Bluegill sunfish (*Lepomis pallidus*).
- Redspotted sunfish (*Lepomis humilis*).
- Longeared sunfish (*Lepomis megalotis*).
- Common sunfish (*Eupomotis gibbosus*).
- Warmouth, goggle-eye (*Chænobryttus gulosus*).

THE PERCHES (PERCIDÆ):
- Pike perch (*Stizostedion vitreum*).
- Yellow perch (*Perca flavescens*).

THE PIKES (LUCIIDÆ):
- Little pickerel (*Lucius vermiculatus*).
- Common pickerel (*Lucius lucius*).
- Muskallunge (*Lucius masquinongy*).

THE BASSES (SERRANIDÆ):
- Striped bass, rockfish (*Roccus lineatus*).
- White bass (*Roccus chrysops*).
- White perch (*Morone americana*).
- Yellow bass (*Morone interrupta*).

THE DRUMS (SCIAENIDÆ):
- Fresh-water drum, lake sheepshead (*Aplodinotus grunniens*).

THE CODS (GADIDÆ):
- Cod (*Gadus callarias*).
- Haddock (*Melanogrammus æglefinus*).
- Pollock (*Pollachius virens*).

THE FLOUNDERS (PLEURONECTIDÆ):
- Winter flounder, American flatfish (*Pseudopleuronectes americanus*).

CRUSTACEANS:
- American lobster (*Homarus americanus*).

The following table gives the different fish-cultural stations and substations operative in 1919, the period of operation of each, and the number of fish and eggs, by species, furnished for distribution by each station, through propagation, through collections from auxiliary stations, and through rescuing fish from overflowed lands of the Mississippi Basin. It will be noted that transfers of fish and eggs from station to station are frequent. Such transfers are made in the interest of economy and convenience where the shipments consist of eggs, and give advantageous distribution centers in the case of young fish.

STATIONS OPERATED AND OUTPUT OF EACH FOR FISCAL YEAR 1919.

[NOTE.—See explanations of reference characters on p. 12.]

Station and period of operation.	Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
Afognak, Alaska:[a] Entire year	Humpback salmon		2,142,000		2,142,000
	Sockeye salmon	20,700,000	11,906,000	13,677,000	46,283,000
Atchafalaya, La.: Mar.-Apr.	Buffalofish		110,940,000		110,940,000
Baird, Calif.: Entire year	Chinook salmon			2,280,000	2,280,000
Battle Creek, Calif.—Entire year	do	638,000		4,509,000	5,147,000
Mill Creek, Calif.—Entire year	do	11,164,500		3,498,800	14,662,800
Baker Lake, Wash.: Entire year	do			86,500	86,500
	Sockeye salmon			8,622,000	8,622,000
Birdsview, Wash.[b]—Entire year	Blackspotted trout			154,000	154,000
	Chinook salmon		24,320	162,000	186,320
	Chum salmon		848,840		848,840
	Humpback salmon		1,969,000		1,969,000
	Silver salmon		4,687,520	769,600	5,457,120
	Sockeye salmon			45,560	45,560
	Steelhead salmon	25,000		198,865	223,865

STATIONS OPERATED AND OUTPUT OF EACH FOR FISCAL YEAR 1919—Continued.

[NOTE.—See explanations of reference characters on p. 12.]

Station and period of operation.	Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
Baker Lake, Wash.—Con.					
Darrington, Wash.—Mar.-June	Chum salmon		619,000		619,000
	Silver salmon		18,900		18,900
Duckabush, Wash.—Entire year	Chum salmon		2,780,000	2,803,160	5,583,160
	Humpback salmon			369,958	369,958
	Silver salmon			208,380	208,380
Quilcene, Wash.[c]—Entire year	Chinook salmon		18,250		18,250
	Chum salmon		1,545,000	860,600	2,405,600
	Humpback salmon		385,500		385,500
	Silver salmon			354,000	354,000
	Steelhead salmon	50,000		170,000	220,000
Sultan, Wash.—Entire year	Chinook salmon		246,430		246,430
	Silver salmon		2,157,600		2,157,600
	Steelhead salmon			92,500	92,500
Berkshire, Mass.: Entire year	Brook trout			542,300	542,300
	Rainbow trout		10,500	1,500	12,000
	Smallmouth black bass		2,000		2,000
Boothbay Harbor, Me.: Entire year	Alewife		25,000		25,000
	Cod		1,067,000		1,067,000
	Flounder		1,279,256,000		1,279,256,000
	Haddock		192,000		192,000
	Lobster		7,500,000		7,500,000
	Pollock		1,714,000		1,714,000
Bozeman, Mont.:[d] Entire year	Blackspotted trout			945,750	945,750
	Brook trout			688,350	688,350
	Grayling		275,000		275,000
	Rainbow trout	1,580,000		869,750	2,449,750
Glacier Park, Mont.—Mar.-June	Brook trout		350,000		350,000
Yellowstone, Wyo.[e]—July-Sept	Blackspotted trout	12,000	200,000		212,000
Bryans Point, Md.:[f] Feb.-May	Shad		44,864,550		44,864,550
	Yellow perch		153,679,500		153,679,500
Cape Vincent, N. Y.:[g] Entire year	Brook trout		658,500		658,500
	Chinook salmon		627,600	150,000	777,600
	Lake herring	146,700,000	86,180,000		232,880,000
	Lake trout		467,975		467,975
	Whitefish	25,450,000	41,670,000		67,120,000
	Yellow perch		7,000,000		7,000,000
	Miscellaneous fishes		1,000,000		1,000,000
Central Station, Washington, D. C.: Entire year	Brook trout			16,000	16,000
	Rainbow trout			11,500	11,500
	Shad		300,000		300,000
	Whitefish		750,000		750,000
	Yellow perch		2,500,000		2,500,000
Clackamas, Oreg.:[h] Entire year	Blackspotted trout			80,000	80,000
	Brook trout			64,400	64,400
	Chinook salmon			3,081,000	3,081,000
	Rainbow trout			110,800	110,800
	Steelhead salmon			25,000	25,000
Applegate, Oreg.—Entire year	Chinook salmon			30,850	30,850
	Silver salmon			494,650	494,650
	Steelhead salmon	500,000		32,000	532,000
Big White Salmon, Wash.—Entire year	Chinook salmon			9,102,000	9,102,000
Little White Salmon, Wash.[i]—Entire year	do			9,177,500	9,177,500
	Chum salmon		460,800		460,800
	Sockeye salmon			939,960	939,960
Rogue River, Oreg.—Entire year	Blackspotted trout			37,700	37,700
	Chinook salmon			1,002,100	1,002,100
	Rainbow trout			48,000	48,000
	Silver salmon			97,500	97,500
	Steelhead salmon			775,000	775,000

Stations Operated and Output of Each for Fiscal Year 1919—Continued.

[Note.—See explanations of reference characters on p. 12.]

Station and period of operation.	Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
Clackamas, Oreg.—Contd.					
Upper Clackamas, Oreg.—					
Entire year	Chinook salmon			1,211,000	1,211,000
	Silver salmon			2,200	2,200
	Steelhead salmon			10,500	10,500
St. Helens, Oreg.—					
July–June	Shad		11,716,700		11,716,700
Willamette, Oreg.—					
July–June	do		3,449,000		3,449,000
Washougal, Wash.—					
May–June	Steelhead salmon	205,000	100,000		305,000
Cold Springs, Ga.:					
Entire year	Black bass		87,000	126,450	213,450
	Catfish			8,904	8,904
	Crappie			400	400
	Sunfish			66,900	66,900
Milltown, Ga.—					
May	Black bass			37,100	37,100
Craig Brook, Me.:					
Entire year	Atlantic salmon		2,390,000	700	2,390,700
	Brook trout		516,000	63,200	579,200
	Landlocked salmon		90,925		90,925
Duluth, Minn.: j					
Entire year	Brook trout		202,500	67,500	270,000
	Lake trout	1,550,000	10,327,500	692,500	12,570,000
	Pike perch	5,000,000	12,500,000		17,500,000
	Whitefish		8,500,000		8,500,000
Edenton, N. C.:					
Entire year	Black bass		4,000	19,585	23,585
	Shad		23,694,000		23,694,000
	Sunfish			12,700	12,700
	White perch		2,035,000		2,035,000
	Yellow perch			114	114
Weldon, N. C.—					
Apr.–May	Striped bass		13,540,000		13,540,000
Erwin, Tenn.: k					
Entire year	Black bass		11,200	4,755	15,955
	Brook trout			236,250	236,250
	Rainbow trout			373,900	373,900
	Rock bass			22,935	22,935
	Smallmouth black bass		1,000	6,300	7,300
	Sunfish			12,200	12,200
Fairport, Iowa:					
Entire year	Black bass			10,346	12,346
	Buffalofish		160,000	48,745	208,745
	Carp		899,000	299,002	1,198,002
	Catfish			195,165	195,165
	Crappie			106,030	106,030
	Pike and pickerel			540	540
	Smallmouth black bass			2,190	2,190
	Sunfish			38,679	38,679
	White bass			1,035	1,035
	Yellow perch			3,110	3,110
	Miscellaneous			7,145	7,145
Gloucester, Mass.: l					
Entire year	Cod	243,870,000	42,880,000		286,750,000
	Flounder		138,990,000		138,990,000
	Haddock	200,390,000	129,400,000		329,790,000
	Pollock		702,258,000		702,258,000
Green Lake, Me.:					
Entire year	Brook trout		901,200		901,200
	Landlocked salmon	405,125	322,000	100,441	827,568
	Smelt	3,000,000	6,437,000		9,437,000
	Steelhead salmon			11,232	11,232
Grand Lake Stream, Me. m—					
Entire year	Brook trout		48,480		48,480
	Landlocked salmon		18,947	72,757	91,704
	Steelhead salmon			34,938	34,938
Homer, Minn.:					
Entire year	Black bass			174,366	174,366
	Buffalofish			586,890	586,890
	Carp			10,083,500	10,083,500
	Catfish			6,615,225	6,615,225
	Crappie			8,037,335	8,037,335
	Drum			18,500	18,500
	Pike and pickerel			327,250	327,250
	Rock bass			4,600	4,600
	Sunfish			627,200	627,200

STATIONS OPERATED AND OUTPUT OF EACH FOR FISCAL YEAR 1919—Continued.

[NOTE.—See explanations of reference characters on p. 12.]

Station and period of operation.	Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
Homer, Minn.—Contd.					
Entire year	White bass			1,500	1,500
	Yellow perch			2,213,280	2,213,280
	Miscellaneous			70,400	70,400
La Crosse, Wis.:					
Entire year	Black bass			45,990	45,990
	Brook trout		112,470	264,500	376,970
	Buffalofish			3,000	3,000
	Carp			2,450,000	2,450,000
	Catfish			793,900	793,900
	Crappie			1,514,500	1,514,500
	Pike perch		5,000,000	10,710	5,010,710
	Pike and pickerel			30,700	30,700
	Rainbow trout			55,500	55,500
	Rock bass			170	170
	Sunfish			16,000	16,000
	Yellow perch			79,790	79,790
	Miscellaneous			352,600	352,600
Leadville, Colo.: n					
Entire year	Blackspotted trout			774,100	774,100
	Brook trout	100,000		1,902,500	2,002,500
	Lake trout			20,000	20,000
	Loch Leven trout			60,000	60,000
	Rainbow trout			195,000	195,000
Louisville, Ky.:					
Entire year	Black bass			700	700
	Brook trout			150	150
	Crappie			75	75
	Pike perch		1,700,000		1,700,000
	Rainbow trout			4,250	4,250
	Rock bass			6,050	6,050
	Smallmouth black bass		30,000	8,200	38,200
	Sunfish			49,100	49,100
	Yellow perch		380,000		380,000
Cairo, Ill.—					
Sept.-Oct	Black bass			100	100
	Buffalo fish			45,500	45,500
	Catfish			1,110,000	1,110,000
	Crappie			299,500	299,500
	Sunfish			183,000	183,000
	White bass			1,000	1.000
Mammoth Spring, Ark.:					
Entire year	Black bass		2,000	23,070	25,070
	Rock bass			1,910	1,910
	Smallmouth black bass		47,600	2,260	49,860
Manchester, Iowa: o					
Entire year	Brook trout			404,390	404,390
	Pike perch		1,900,000		1,900,000
	Rainbow trout	72,000		247,390	319,390
	Rock bass			17,250	17,250
	Smallmouth black bass			2,820	2,820
	Sunfish			140	140
Bellevue, Iowa—					
July-Dec	Black bass			60,852	60,852
	Buffalo fish			823,850	823,850
	Carp			4,961,660	4,961,660
	Catfish			1,296,245	1,296,245
	Crappie			4,548,420	4,548,420
	Drum			477	477
	Pike and pickerel			947	947
	Sunfish			84,338	84,338
	White bass			4,130	4,130
	Yellow perch			1,268	1,268
	Miscellaneous			89,105	89,105
North McGregor, Iowa—					
July-Dec	Black bass			72,730	72,730
	Buffalo fish			1,066,000	1,066,000
	Carp			1,941,100	1,941,100
	Catfish			1,170,035	1,170,035
	Crappie			1,258,200	1,258,200
	Pike and pickerel			16,500	16,500
	Sunfish			14,710	14,710
	White bass			1,000	1,000
	Yellow perch			42,390	42,390
	Miscellaneous			228,000	228,000
Meredosia, Ill.: p					
Entire year	Black bass			58,149	58,149
	Buffalo fish			17,400	17,400
	Carp			18,800	18,800
	Catfish			1,329,600	1,329,600

STATIONS OPERATED AND OUTPUT OF EACH FOR FISCAL YEAR 1919—Continued.

[NOTE.—See explanations of reference characters on p. 12.]

Station and period of operation.	Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
Meredosia, Ill.—Contd. Entire year	Crappie			41,975	41,975
	Sunfish			39,150	39,150
	Yellow bass			600	600
	Yellow perch			14,600	14,600
Nashua, N. H.: Entire year	Brook trout			664,825	664,825
	Landlocked salmon			6,800	6,800
	Rainbow trout			13,224	13,224
	Smallmouth black bass		63,500	625	64,125
Neosho, Mo.:[q] Entire year	Black bass			19,012	19,012
	Catfish			800	800
	Crappie			6,550	6,550
	Rainbow trout	82,700		125,286	207,986
	Rock bass			9,340	9,340
	Smallmouth black bass			3,200	3,200
	Sunfish			24,464	24,464
	Yellow perch	160,000	130,000		290,000
Northville, Mich.: Entire year	Brook trout		193,000	249,500	442,500
	Rainbow trout		14,000	23,000	37,000
	Smallmouth black bass			18,075	18,075
Charlevoix, Mich.:[r] Entire year	Lake trout	1,518,000	17,700,000		19,218,000
	Pike perch		10,000,000		10,000,000
	Steelhead salmon		28,125	24,358	52,583
	Whitefish	15,280,000	20,000,000		35,280,000
Detroit, Mich.—Apr.-May	Pike perch		3,800,000		3,800,000
Bay City, Mich.—Apr	....do	348,800,000			348,800,000
Orangeburg, S. C.: Entire year	Black bass			226,300	226,300
	Catfish			1,080	1,080
	Sunfish			48,500	48,500
Put in Bay, Ohio:[s] Entire year	Carp		22,800,000		22,800,000
	Pike perch	23,100,000	70,300,000		93,400,000
	Whitefish	70,920,000	126,300,000		197,220,000
	Yellow perch		12,000,000		12,000,000
Quinault, Wash.: Entire year	Chinook salmon		100,000	109,400	209,400
	Silver salmon		600,000	419,400	1,019,400
	Sockeye salmon		1,200,000	5,678,000	6,878,000
St. Johnsbury, Vt.:[t] Entire year	Brook trout	7,000	1,108,700	52,715	1,168,415
	Lake trout			2,210	2,210
	Landlocked salmon			1,256	1,256
	Rainbow trout		14,000		14,000
	Smallmouth black bass		6,000		6,000
	Steelhead salmon			3,011	3,011
Holden, Vt.—Entire year	Brook trout		81,000	24,725	105,725
	Lake trout			10,700	10,700
	Landlocked salmon			1,300	1,300
	Steelhead salmon			31,586	31,586
Lakewood, Vt.—Apr.-May	Pike perch	29,300,000	71,500,000		100,800,000
	Yellow perch	22,500,000	3,600,000		26,100,000
San Marcos, Tex.: Entire year	Black bass		1,950	107,743	109,693
	Crappie			280	280
	Rock bass			1,411	1,411
	Sunfish		3,050	6,765	9,815
Saratoga, Wyo.:[u] Entire year	Blackspotted trout			369,000	369,000
	Brook trout			693,000	693,000
	Rainbow trout	805,000		226,000	226,000
	Steelhead salmon			41,000	41,000
Spearfish, S. Dak.: Entire year	Blackspotted trout			261,000	261,000
	Brook trout			668,100	668,100
	Lake trout			41,975	41,975
	Loch Leven trout			13,000	13,000
	Rainbow trout			223,790	223,790
	Steelhead salmon			43,300	43,300
Springville, Utah:[v] Entire year	Blackspotted trout	121,000		253,550	374,550
	Brook trout			82,750	82,750
	Rainbow trout	400,000		308,650	708,650

STATIONS OPERATED AND OUTPUT OF EACH FOR FISCAL YEAR 1919—Continued.

[NOTE.—See explanations of reference characters below.]

Station and period of operation.	Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
Springville, Utah—Contd.					
Paris, Idaho—					
Feb.-May	Whitefish		1,495,000		1,495,000
Tupelo, Miss.:					
Entire year	Black bass		319,700	73,165	392,865
	Crappie			675	675
	Sunfish			56,650	56,650
	Warmouth bass			1,059	1,059
Friar Point, Miss.—					
July-Dec	Black bass			30,443	30,443
	Buffalofish			4,950	4,950
	Catfish			121,276	121,276
	Crappie			26,389	26,389
	Rock bass			440	440
	Sunfish			69,125	69,125
White Sulphur Springs, W. Va.:					
Entire year	Brook trout			861,300	861,300
	Rainbow trout			137,050	137,050
	Rock bass			2,400	2,400
	Smallmouth black bass		50,500	840	51,340
	Sunfish			900	900
Woods Hole, Mass.:					
Entire year	Cod		20,384,000		20,384,000
	Flounder		1,235,946,000		1,235,946,000
	Mackerel		9,508,000		9,508,000
Wytheville, Va.: [w]					
Entire year	Black bass			12,925	12,925
	Brook trout			103,300	103,300
	Rainbow trout			464,200	464,200
	Rock bass			10,350	10,350
	Smallmouth black bass			360	360
	Sunfish			3,115	3,115
Yes Bay, Alaska: [x]					
Entire year	Humpback salmon		930,000		930,000
	Sockeye salmon	3,440,100	26,650,000	8,679,700	39,829,700
Gross total		1,177,870,545	4,548,516,830	151,832,593	5,878,219,968
Loss in transit			1,176,505	58,113	1,234,618
Net output		1,177,870,545	4,547,340,325	151,774,480	5,876,985,350

NOTES TO REFERENCE CHARACTERS IN PRECEDING TABLE.

For convenience in handling, transfers were made as follows:

[a] Afognak to Baker Lake, 5,760,000 humpback salmon; to Quinault, 5,000,000 sockeye-salmon eggs.
[b] Birdsview to Charlevoix, 25,000; to St. Johnsbury, 50,000 steelhead-salmon eggs.
[c] Quilcene to Holden, 50,000; to Green Lake, 50,000 steelhead-salmon eggs.
[d] Bozeman to Spearfish, 25,000; to Manchester, 25,000; to Clackamas, 200,000; to Northville, 25,000; to Wytheville, 75,000; to White Sulphur Springs, 25,000; to Rogue River, 100,000; to Birdsview, 50,000 rainbow-trout eggs.
[e] Yellowstone to Spearfish, 345,000; to Saratoga, 427,000; to Birdsview, 105,000; to Clackamas, 105,000; to Glacier Park, 265,000 blackspotted-trout eggs.
[f] Bryans Point to Central Station, 875,000 shad eggs, 3,120,000 yellow-perch eggs.
[g] Cape Vincent to Central Station, 500,000 whitefish eggs, 1,500,000 lake-herring eggs.
[h] Clackamas to Central Station, 20,000 chinook-salmon eggs.
[i] Little White Salmon to Cape Vincent, 820,000 chinook-salmon eggs.
[j] Duluth to Leadville, 25,000 lake-trout eggs; to Manchester, 2,000,000; to La Crosse, 5,000,000 pike-perch eggs.
[k] Erwin to Cold Springs, 2,000 rock-bass fingerlings.
[l] Gloucester to Boothbay Harbor, 2,100,000 pollock eggs.
[m] Grand Lake Stream to Craig Brook, 100,000 landlocked-salmon eggs.
[n] Leadville to Glacier Park, 500,000 brook-trout eggs; to Saratoga, 206,000 rainbow-trout eggs; to Cedar Island Lodge, 100,000 brook-trout eggs in exchange for rainbow-trout eggs.
[o] Manchester to Northville, 24,700; to La Crosse, 100,000 rainbow-trout eggs.
[p] Meredosia to Neosho, 1,000 catfish fingerlings.
[q] Neosho to Meredosia, 5,000 rock-bass fingerlings; to Erwin, 51,000; to Central Station, 15,000 rainbow-trout eggs.
[r] Charlevoix to Holden, 50,000 lake-trout eggs.
[s] Put-in-Bay to Duluth, 22,400,000; to Charlevoix, 64,680,000; to Central Station, 800,000 whitefish eggs; to Louisville, 2,000,000; to La Crosse, 7,000,000 pike-perch eggs.
[t] St. Johnsbury to Berkshire, 50,000; to Central Station, 17,960 brook-trout eggs.
[u] Saratoga to St. Johnsbury, 50,000; to Leadville, 206,000 rainbow-trout eggs.
[v] Springville to Saratoga, 608,400 brook-trout eggs.
[w] Wytheville to Erwin, 23,000; to Neosho, 22,000; to Manchester, 24,000; to Central Station, 10,000 rainbow-trout eggs.
[x] Yes Bay to Birdsview, 406,000 humpback-salmon eggs; to Little White Salmon, 1,059,900 sockeye-salmon eggs.

The eggs hatched at the main stations and substations listed in the foregoing table are in many cases obtained from auxiliary sources, usually temporary stations occupied during the season only or, in some instances, mere camps, which are shifted from year to year. In the Great Lakes and off the New England coast collections are made by the Bureau's vessels or boats in favorable localities. The following temporary stations and collecting points operative for the periods indicated, furnished eggs of the given species for the main hatcheries during 1919:

EGG-COLLECTING STATIONS FOR FISCAL YEAR 1919.

Station.	Period of operation.	Species handled.
Baker Lake, Wash.:		
Brinnon, Wash	November to June	Chum, silver, and steelhead salmons.
Illabott Creek, Wash	November to February	Chum and silver salmons.
Bozeman, Mont.:		
Madison Valley, Mont	March to June	Grayling, rainbow trout.
Clear Creek, Wyo	July and June	Blackspotted trout.
Columbine Creek, Wyo	do	Do.
Cub Creek, Wyo	do	Do.
Pelican Creek, Wyo	do	Do.
Soda Butte, Wyo	do	Do.
Cape Vincent, N. Y.:		
Bygotts Point, N. Y	November	Whitefish.
Chaumont Bay, N. Y	do	Lake herring, whitefish.
Fair Haven Bay, N. Y	do	Lake herring.
Fishing Creek, N. Y	do	Whitefish.
Grass Bay, N. Y	May	Yellow perch.
Henderson Harbor, N. Y	November	Lake herring.
Pigeon Island, N. Y	do	Lake trout, whitefish.
Sodus Point, N. Y	do	Lake herring.
South Bay, N. Y	do	Whitefish.
Stony Island, N. Y	October to November	Lake trout.
Three Mile Bay, N. Y	do	Lake herring, whitefish.
Clackamas, Oreg.:		
Eagle Creek, Oreg	March to June	Steelhead salmon.
Elk Creek, Oreg	October to April	Blackspotted trout, silver and steelhead salmons.
Leadville, Colo.:		
Antero Lakes, Colo	May to June	Blackspotted and rainbow trouts.
Crystal Lake, Colo	November	Brook trout.
Engelbrecht Lakes, Colo	October to November	Do.
Evergreen Lake, Colo	do	Do.
Northfield Lake, Colo	do	Do.
Turquoise Lake, Colo	do	Do.
Woodland Park, Colo	do	Do.
Northville, Mich.:		
Alpena, Mich	do	Lake trout, pike perch.
Cheboygan, Mich	do	Do.
Detour, Mich	do	Do.
Frankfort, Mich	do	Do.
Hammond Bay, Mich	November	Whitefish.
Leeland, Mich	do	Lake trout.
Manistique, Mich	October to November	Do.
Mackinaw City, Mich	do	Do.
Naubinway, Mich	November	Whitefish.
Northport, Mich	do	Lake trout.
St. Ignace, Mich	do	Whitefish.
St. James, Mich	do	Lake trout, whitefish.
Scotts Point, Mich	do	Whitefish.
Put in Bay, Ohio:		
Catawba Island, Ohio	November to December	Do.
Kellys Island, Ohio	do	Do.
Isle St. George, Ohio	November, December, April	Whitefish, pike perch.
Middle Bass, Ohio	do	Whitefish.
Monroe, Mich	do	Do.
Fort Clinton, Ohio	November to December, April and June.	Whitefish, pike perch, carp.
Toledo, Ohio	November, December, April	Whitefish, pike perch.
St. Johnsbury, Vt.:		
Chittenden Dam, Vt	April to May	Steelhead salmon.
Darling Pond, Vt	September to November	Brook trout.
Lake Mitchell, Vt	do	Do.
Saratoga, Wyo.: Lake Creek, Wyo.	April to May	Rainbow trout.
Spearfish, S. Dak.:		
Kingsley Lake, S. Dak	October to December	Brook and Loch Leven trouts.
Schmidt Lakes, S. Dak	do	Do.
LaPlant Ranch, S. Dak	do	Brook trout.
Springville, Utah: Paris, Idaho	November to April	Whitefish.
Woods Hole, Mass.: Wickford, R.I.	February, May	Flounder.

DISTRIBUTION OF OUTPUT.

The following table shows in summarized form the total disposition of all fish and eggs propagated and of all fish rescued from overflowed lands and restored to original waters during the fiscal year ended June 30, 1919, or, in other words, the total output with all losses in transportation deducted:

Summary, by Species, of Total Distribution of Fish and Eggs, Fiscal Year 1919.

Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
Catfish			12,639,830	12,639,830
Carp		23,699,000	19,754,060	43,453,060
Buffalofish		111,100,000	2,596,335	113,696,335
Shad		84,024,250		84,024,250
Alewife		25,000		25,000
Whitefish	111,650,000	198,715,000		310,365,000
Lake herring (cisco)	146,700,000	86,180,000		232,880,000
Silver salmon		7,464,020	2,345,730	9,809,750
Chinook salmon	11,802,500	1,016,600	34,400,150	47,219,250
Sockeye salmon	24,140,100	39,756,000	37,642,220	101,638,320
Humpback salmon		5,426,500	369,960	5,796,460
Chum salmon		6,253,640	3,663,760	9,917,400
Steelhead salmon	805,000	128,125	1,493,290	2,426,415
Atlantic salmon		2,390,000	700	2,390,700
Landlocked salmon	405,125	424,870	182,560	1,012,555
Rainbow trout	2,939,820	38,500	3,409,190	6,387,510
Blackspotted trout	133,000	200,000	2,875,100	3,208,100
Loch Leven trout			73,000	73,000
Lake trout	3,068,000	28,495,475	765,180	32,328,655
Brook trout	107,000	4,158,050	7,638,615	11,903,665
Grayling		275,000		275,000
Smelt	3,000,000	6,437,000		9,437,000
Pike and pickerel			375,935	375,935
Fresh-water drum			18,975	18,975
Crappies			15,837,865	15,837,865
Largemouth black bass		425,045	1,100,420	1,525,465
Smallmouth black bass		195,700	43,745	239,445
Rock bass			75,460	75,460
Warmouth bass			1,060	1,060
Sunfish (bream)		3,050	1,350,115	1,353,165
Pike perch	406,200,000	175,550,000	10,710	581,760,710
Yellow perch	22,660,000	179,289,500	2,353,800	204,303,300
White perch		2,035,000		2,035,000
White bass			8,865	8,865
Yellow bass			600	600
Striped bass		13,540,000		13,540,000
Mackerel		9,508,000		9,508,000
Cod	243,870,000	64,331,000		308,201,000
Pollock		703,972,000		703,972,000
Haddock	200,390,000	129,592,000		329,982,000
Winter flounder		2,654,192,000		2,654,192,000
Miscellaneous fishes		1,000,000	747,250	1,747,250
Lobster		7,500,000		7,500,000
Total	1,177,870,545	4,547,340,325	151,774,480	5,876,985,350

For convenience in reference the three tables immediately following give summaries of certain phases of the total disposition of fish and eggs for the fiscal year 1919—(1) allotments of fish and eggs to State fish commissions; (2) shipments of fish and eggs to foreign countries; and (3) fish rescued from overflowed lands.

Allotments of Fish and Fish Eggs to State Fish Commissions, Fiscal Year 1919.

[Eggs are indicated by an asterisk (*); fry, by a dagger (†); all others are fingerlings.]

State and species.	Number.
California: Chinook salmon	*11,802,500
Connecticut:	
Catfish	1,100
Crappie	3,600
Sunfish	1,400
Yellow perch	1,625
Idaho: Rainbow trout	*50,000
Illinois: Whitefish	*5,000,000
Indiana: Pike perch	*8,050,000
Iowa:	
Pike perch	*5,000,000
Rainbow trout	*70,000
Rock bass	13,000
Kentucky:	
Brook trout	150
Rainbow trout	4,250
Yellow perch	†100,000
Maine: Landlocked salmon	*405,125
Maryland:	
Rainbow trout	*50,000
Rock bass	2,900
Sunfish	1,415
Miscellaneous fishes	†1,000,000
Massachusetts: Pike perch	*5,100,000
Michigan:	
Lake trout	*1,000,000
Pike perch	*288,800,000
Whitefish	*20,000,000
Minnesota:	
Black bass	6,500
Lake trout	*250,000
Rainbow trout	*50,000
Steelhead salmon	*125,000
Missouri: Yellow perch	*160,000 †40,000
Montana:	700
Black bass	3,000
Brook trout	2,400
Catfish	1,300
Crappie	780
Yellow perch	*1,000,000
Rainbow trout	*25,000
Nevada: Rainbow trout	
New Hampshire:	*6,000,000
Pike perch	2,225
Rainbow trout	
New Jersey:	*35,000
Rainbow trout	*25,000
Steelhead salmon	*21,500,000
Yellow perch	
New York:	
Lake herring	*32,500,000
Lake trout	*1,800,000
Landlocked salmon	†15,000
Pike perch	*60,000,000
Steelhead salmon	*200,000
Strawberry bass	100
Sunfish	100
Whitefish	*9,000,000
Ohio: Whitefish	*10,800,000
Oklahoma:	
Black bass (largemouth)	3,600
Black bass (smallmouth)	400
Rainbow trout	7,800
Oregon:	
Blackspotted trout	*121,000
Rainbow trout	*765,000
Sockeye salmon	*3,440,100
Pennsylvania:	
Lake herring	*88,700,000
Pike perch	*15,050,000
Whitefish	*37,070,000
Rhode Island:	
Pike perch	†200,000
Black bass (smallmouth)	†7,500
South Dakota:	
Brook trout	45,000
Rainbow trout	50,000
Tennessee: Rainbow trout	*42,700
Vermont:	
Pike perch	*16,200,000
Steelhead salmon	*50,000
Washington:	
Rainbow trout	*100,000
Steelhead salmon	*230,000
Wisconsin:	
Black bass	5,000
Catfish	7,200
Whitefish	*20,000,000
Wyoming:	
Rainbow trout	*100,000
Steelhead salmon	*50,000
Total	*670,716,425 †1,362,500 165,545

Shipments of Fish and Fish Eggs to Foreign Countries, Fiscal Year 1919.

[Eggs are indicated by an asterisk (*); all others are fingerlings.]

Country and species.	Number.
Canada: Canadian Government—	
Lake herring	*25,500,000
Sockeye salmon	*20,700,000
Whitefish	*9,000,000
Mexico: Nacozari—	
Black bass	5,000
Strawberry bass	5,000
Total	*55,200,000 10,000

DISPOSITION OF FISH RESCUED, FISCAL YEAR 1919.

Species.	Restored to original waters.	Delivered to applicants.	Species.	Restored to original waters.	Delivered to applicants.
Black bass	173,443	272,511	Smallmouth black bass	2,190	....
Buffalofish	2,593,360	2,975	Sunfish	986,692	80,960
Carp	19,752,602	960	White bass	8,665	....
Catfish	12,479,146	138,300	Yellow bass	....	600
Crappie	15,725,416	92,875	Yellow perch	2,333,598	20,840
Drum	18,977	....	Miscellaneous	747,250	....
Pike perch	10,710	....			
Pike	375,937	....	Total	55,208,796	610,021
Rock bass	810	....			

On the pages following is shown in detail the distribution of fish eggs, fry, fingerlings, yearlings, and adults, by species, by States or countries, and by municipalities, alphabetically arranged, and by waters, for the fiscal year ended June 30, 1919.

The distribution was composed largely of fingerlings, yearlings, and adults, though quite a number of eggs and fry of some species were distributed. In succeeding pages figures preceded by an asterisk (*) indicate an egg distribution; those preceded by a dagger (†), a fry distribution. All other enumerations represent fingerlings, yearlings, and adults.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919.

CATFISH.

Disposition.	Number.
Alabama:	
Abanda, Harris's pond	125
Andalusia, Langston's pond	450
Calhoun, Cane Creek	125
Dadeville, Knight's pond	125
Eufaula, Clark's pond	200
Gurley, Flint River	200
Peterman, Rumbley Pond	120
Phil Campbell, Morrison's pond	300
Red Level, Butler's pond	81
Sellers, Mineral Pond	400
Arizona:	
Benson, Murray's pond	150
Bisbee, Artesia Pond	150
Cochise, Bonny Rancho Ponds	300
Burney's pond	150
Dreamy Waters Pond	150
Globe, Roosevelt Lake	1,950
Nogales, Alamo Lake	300
Pasture Pond	150
Skull Valley, Coughlan's pond	400
Tempe, Tempe Drainage Canal	150
Arkansas:	
Black Rock, Black River	a 490
Conway, Cypress Pond	400
Everton, Anderson's pond	500
Harrison, Mill Creek	300
Heber Springs, Peter Creek	100
Higden, Little Red River, South Fork	200
Kerlin, Price's pond	80
Poe, Indian Creek	200
St. Joe, Buffalo River	1,000
Tokio, McLarty's pond	500
California: Summit, Deep Creek Pond	400
Colorado:	
Debeque, Libbey's pond	600
Elizabeth, Greyhound Lake	300
Flagler, Crystal Spring Creek	300
Republican River, South Fork	600
Hillside, Angico Pond	2,000
Longmont, Dawson Lake	700
Connecticut:	
Hartford, State fish commission	1,100
Winsted, Park Pond	1,000
Florida:	
DeFuniak Springs, Chipley Park Lake	240
Lakeland, Mirror Lake	150
Georgia:	
Augusta, Tarver's pond	70
Boneville, Wilson's pond	70
Columbus, Hollywood Pond	150
Covington, Hereford Lake	75
Crawfordville, Chapman Creek	70
Decatur, Morgan's pond	200
Gibson, Walker's pond	600
Halloca, King's pond	225
Hamilton, Spears's pond	75
Harris, Bonner's pond	225
La Grange, Lee's pond	300
Lumpkin, Perkins's pond	200
Monroe, Felkers's pond	50
Newman, Bar Pond	300
Palmetto, Roan's pond	300
Sparta, Archer's pond	140
Waco, Bailey's pond	210
Warm Springs, Cane Creek	600
Fowler Lake	600
Warm Creek	148
Illinois:	
Alexander, Bergschneider's pond	600
Alpha, Crescent Lake	800
Apple River, Apple River	600
Aquauka, Mississippi River	a 2,100
Blanding, Mississippi River	a 129,600
Cairo, Mississippi River	a 97,000
Carrollton, Walnut Hall Lake	600
Council Hill, Apple River	750
Freeport, Richland Creek	150
Galena, Mississippi River	a 226,430
Hudgens, Hudgens Lake	200
McConnell, Pecatonica River	150
Meredosia, Illinois River	a 1,287,800

a Rescued from overflowed lands and restored to original waters.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

CATFISH—Continued.

Disposition.	Number.
Illinois—Continued.	
Meredosia, Meredosia Bay	*a* 2,600
Murrayville, Webster's pond	200
Napierville, Du Page River	8,400
New Boston, Mississippi River	*a* 122,910
Red Oak, Richland Creek	225
Sand Prairie, Mississippi River	*a* 596,200
Scales Mound, Fevre River	600
Stonefort, Johnson's pond	200
Indiana:	
Mott Station, Binkley's pond	200
Pierceton, Webster Lake	600
Romney, Hazelwood Pond	750
Russellville, Maple Lawn Pond	200
Terre Haute, Blue Hole Pond	500
Lake Junietta	500
Iowa:	
Bellevue, Mississippi River	*a* 48,250
Fairport, Mississippi River	*a* 41,500
Harpers Ferry, Mississippi River	*a* 64,000
Hurstville, Mississippi River	*a* 51,900
Lime Springs, Upper Iowa River	3,000
McDolans Dam, Mississippi River	*a* 41,000
Manchester, Maquoketa River	7,035
North McGregor, Mississippi River	*a* 779,451
Smiths Ferry, Mississippi River	*a* 142,000
Sny Magill, Mississippi River	*a* 29,000
Kentucky:	
East Cairo, Ohio River	*a* 688,000
Haags Spur, Clear Lake	*a* 325,000
Hodgenville, Nolin River	200
Shelbyville, Caplinger's pond	200
Soldier, Ashland Pond	200
Maryland:	
Catoctin, Potomac River	250
Glendale, Folly Run	800
Hoods Mill, Patapsco River	400
Massachusetts:	
Fitchburg, Ashburnham Pond	180
Knops Pond	100
Notown Pond	180
Paradise Pond	180
Whalom Lake	180
Wrights Pond	180
Lenox, Lake Mahkeenac	400
Norton, Spot Pond	60
Worcester, Lake Quinsigamond	430
Michigan:	
Bruce Crossing, Kennedy Lake	200
Cressey, Crooked Lake	300
Jackson, Vandercook Lake	400
Sidnaw, Sidnaw Creek	200
Vanderbilt, Round Lake	300
Smolsz Pond	200
Minnesota:	
Cass Lake, Lake Mabel	150
Homer, Mississippi River	*a* 6,590,575
Red Wing, Mississippi River	*a* 28,165
Mississippi:	
Brookhaven, Smith's pond	250
Centreville, Ashwood Pond	500
Friar Point, Mississippi River	*a* 112,425
Natchez, Lake Stowers	750
Woodville, Ogden's pond	500
Missouri:	
Bevier, Nisbeth's pond	300
Boonville, Orchard Pond	600
Montana:	
Baker, Baker Lake	1,050
Billings, Yellowstone River	750
Glendive, Yellowstone River	1,200
Lavina, Old Channell Pond	900
Malta, Alkali Lake	900
West Alkali Lake	1,050
Miles City, Yellowstone River	1,200
Roy, Box Elder Creek	750
Nebraska:	
Bingham, Dimond Lake	300
Home Lake	600
Lower Anderson Lake	600
Taylor Lake	300
Nevada: Thorne, Fletcher Pond	900
New Hampshire: Nashua, Nashua River	360
New Mexico:	
Abbott, Abbott Lake	800
Albuquerque, Rio Grande River	600
Centreville, Forker's pond	150
Clayton, Boggs's pond	200
Engle, Elephant Butte Lake	400
Jal, Bryant's pond	150
Las Cruces, Hay Stack Pond	200
Rouault's pond	200
Onava, Armstrong Lake	400
Portales, Eden Valley Ranch Pond	150
King's pond	150
New York:	
Cohocton, Cohocton River	400
Cornwall, Popolo Lake	750
Hamilton, Chenango Canal	400
Hancock, Summerset Lake	400
Newark, Coffey Lake	400
North Carolina:	
Badin, Tallassee Lake	30
Burnsville, Bay Mine Lake	300
Corinth, Buckhorn Pond	30
Pee Dee, Blewett Falls Lake	30
Raleigh, Millburnie Pond	30
Statesville, Catawba River	1,500
North Dakota: Ross, Robertson's pond	200
Ohio:	
Blanchester, Moormeir's pond	100
Bremen, Fairview Lake	200
Columbus, Little Walnut Creek	600
Cridersville, Moyer's pond	200
Findlay, Reeg's pond	100
Greenfield, Paint Creek	900
St. Marys, Miami and Erie Canal	900
Woodsfield, Waterworks Pond	100
Oklahoma:	
Cleveland, Mead's pond	200
Mill Creek, Blue River	900
Muldrow, McDole's pond	200
Seminole, Silvers's pond	200
Shawnee, Dunlap's pond	400
Stillwater, Hunter's pond	200
Usna, Hilton's pond	100
Pennsylvania:	
Arcola, Perkiomen Creek, Keysers Dam	600
Perkiomen Creek, Plush Dam	600
Skippack Creek	600
Burnside, Susquehanna River	800
Collegeville, Perkiomen Creek	600
Skippack Creek	600
Doylestown, Randt Mill Pond	100
Robin Run	100
Gap, Pequea Creek	1,380
Gratersford, Perkiomen Creek, Lower Dam	600
Perkiomen Creek, Upper Dam	600
Green Lane, Perkiomen Creek, Lower Dam	600
Perkiomen Creek, Upper Dam	600
La Porte, Celestia Pond	200
Lake Mokomo	200
Moscow, Ergood Pond	400
Oaks, Perkiomen Creek	600
Schuylkill River	600
Orwigsburg, Moyer Pond	340
Pen Argyl, Johnsonville Pond	100
Lake Pauponoming	100

a Rescued from overflowed lands and restored to original waters.

Total Distribution of Fish and Fish Eggs, by Species, Fiscal Year 1919—Continued.

CATFISH—Continued.

Disposition.	Number.
Pennsylvania—Continued.	
Pen Argyl, Seguin Pond	100
Smalls Pond	100
Perkiomenville, Perkiomen Creek	600
Phoenixville, French Creek	600
Rahns Station, Perkiomen Creek	600
St. Clair, Kaufman Pond	680
Schwenksville, Perkiomen Creek Lower Dam	600
Perkiomen Creek, Upper Dam	600
Sewickley, Clinton Pond	800
Spring Mount, Perkiomen Creek	600
Valley Forge, Schuylkill River	900
Valley Creek Pond	300
Yerkes, Perkiomen Creek	600
South Carolina:	
Chester, Welch Fork Creek	80
Eureka, Slaton's pond	1,000
Lowndesville, Rocky River	800
Salley, Cook's pond	1,600
South Dakota:	
Conata, Huether's pond	300
Dallas, Valley View Lake	800
Faith, Stewart's pond	200
Fort Pierre, Reese's pond	500
Sorensen Pond	500
Quinn, Johnston's pond	300
Reeder, Duck Pond	400
Laisey's pond	400
Spearfish, Johnson's pond	300
Nelson's pond	300
Trip, Mogck's pond	400
Tyndall, Merkel Lake	400
Wall, Babcock's pond	300
Tennessee:	
Cleveland, Mitchell's pond	1,000
McMinnville, Collier's pond	250
Ramer, Huggins's pond	500
Springfield, Old Deerlick Pond	250
Tullahoma, Cumberland Mill Spring Pond	1,250
Walling, Orchard Lake	500
Texas: Belcherville, Belcherville Lake	400
Utah: American Fork, Utah Lake	3,000
Vermont:	
Brattleboro, Connecticut River	180
Lily Pond	40
Virginia:	
Byllesby, New River, Buck Dam	400
New River, Byllesby Dam	400
Coeburn, Gibson Pond	250
Ivanhoe, Cripple Creek	400
Elk Creek	400
New River	400
New Market, Strickler's pond	200
Woodsplane, Travis Mill Pond	800
Wytheville, Reed Creek, Stones Dam	500
West Virginia:	
Berkeley Springs, Sleepy Creek	1,000
Cowen, Barbe's pond	300
Littleton, Wolf Run	150
Philippi, Sugar Creek	900
Sleepy Creek, Sleepy Creek	1,000
Wisconsin:	
Bagley, Mississippi River	a 70,000
Beaver Dam, Beaver Dam Lake	2,400
Boulder Junction, Grassy Lake	1,000
Campia, Hemlock Lake	600
Clayton, Mississippi River	a 82,100
Hazelhurst, Little Wind Pudding Lake	800
La Crosse, Mississippi River	a 764,100
State fish commission	7,200
Lynxville, Mississippi River	a 70,000
Narrows, Balsam Lake	600
New Lisbon, Lemonweir River	900
Prairie du Chien, Mississippi River	a 101,000
Solon Springs, Lower Twin Lake	150
Tomah, Water Mill Pond	10,800
Wyoming:	
Rozet, Jackson's pond	300
South Hay Creek Pond	600
Upton, Goss's pond	300
Total [b]	12,639,830

CARP.

Disposition.	Number.
Arkansas: Black Rock, Black River	a 885
Illinois:	
Aquaka, Mississippi River	a 1,345
Blanding, Mississippi River	a 189,000
Dallas City, Lake Keokuk	a 1,235
Galena, Mississippi River	a 2,205,000
Meredosia, Illinois River	a 18,700
New Boston, Mississippi River	a 21,390
Sand Prairie, Mississippi River	a 1,445,000
Iowa:	
Clutier, Simsen's pond	375
Fairport, Mississippi River	† 899,000
Mississippi River	a 2,687
Hurstville, Mississippi River	a 65,000
Lanesville, Mississippi River	a 107,000
McDolons Dam, Mississippi River	a 29,000
North McGregor, Mississippi River	a 1,230,000
Pleasant Creek, Mississippi River	a 148,900
Smiths Ferry, Mississippi River	a 801,100
Waukon, Mississippi River	a 15,000
Kansas: Tribune, Rafter's pond	100
Maryland: Lanham, Cook's pond	200
Massachusetts: Norfolk, Hillside Pond	15
Minnesota:	
Clearbrook, Olson Lake	240
Homer, Mississippi River	a 10,083,300
Red Wing, Mississippi River	a 271,460
North Carolina: Monroe, Shute's pond	15
Ohio:	
Oak Harbor, Portage River	† 11,000,000
Port Clinton, Portage River	† 11,800,000
South Carolina: Macedon, Bogy Branch Pond	15
Wisconsin:	
Bagley, Mississippi River	a 410,000
Clayton, Mississippi River	a 86,500
Frenchtown, Mississippi River	a 24,000
La Crosse, Mississippi River	a 2,450,000
Lynxville, Mississippi River	a 146,600
Total	19,754,060 †23,699,000

a Rescued from overflowed lands and restored to original waters.
b Exclusive of 2,400 lost in transit.

Total Distribution of Fish and Fish Eggs, by Species, Fiscal Year 1919—Continued.

BUFFALOFISH.

Disposition.	Number.
Arkansas: Black Rock, Black River	a 4,850
Illinois:	
Aquauka, Mississippi River	a 80
Blanding, Mississippi River	a 150,100
Cairo, Mississippi River	a 24,000
Columbia, Diehl's pond	200
Dallas City, Lake Keokuk	a 1,480
Galena, Mississipp River	a 76,700
Highland, Dubach's pond	100
Meredosia, Illinois River	a 17,000
Meredosia Bay	100
New Boston, Mississippi River	35,035
Sand Prairie, Mississippi River	a 323,600
Iowa:	
Bellevue, Mississippi River	a 10,075
Fairport, Mississippi River	† 160,000 3,205
McDolons Dam, Mississippi River	a 26,000
North McGregor, Mississippi River	a 812,000
Pleasant Creek, Mississippi River	a 136,500
Smiths Ferry, Mississippi River	a 126,400
Sny Magill, Mississippi River	a 2,000
Kentucky:	
East Cairo, Ohio River	a 20,000
Haags Spur, Prairie Lake	a 1,500
Louisiana: Atchafalaya, Atchafalaya River and tributaries	†110,940,000
Minnesota:	
Homer, Mississippi River	a 581,690
Red Wing, Mississippi River	a 4,075
Mississippi: Friar Point, Mississippi River	a 4,950
North Carolina:	
Badin, Tallassee Lake	125
Corinth, Buckhorn Pond	75
Pee Dee, Blewett Falls Lake	125
Raleigh, Milburnie Pond	75
Rock Hill, Catawba River	75
Ohio:	
Port Clinton, Lake Erie	1,110
Sandusky Bay	1,110
Wisconsin:	
Clayton, Mississippi River	a 104,000
La Crosse, Mississippi River	3,000
Lynxville, Mississippi River	a 18,000
Prairie du Chien, Mississippi River	a 80,000
Wyalusing, Mississippi River	a 24,000
Total	†111,100,000 2,596,335

SHAD.

Disposition.	Number.
District of Columbia: Highway Bridge, Potomac River	† 300,000
Maryland:	
Broad Creek, Potomac River	† 4,632,730
Dogue Creek, Potomac River	† 8,385,330
Pascataway Creek, Potomac River	† 10,355,660
Pomonkey Creek, Potomac River	† 3,744,280
Swan Creek, Potomac River	† 4,207,450
North Carolina: Edenton, Albemarle Sound	† 23,694,000
Oregon:	
St. Helens, Willamette River	† 11,716,700
Willamette Falls, Willamette River	† 3,449,000
Virginia:	
Craney Island, Potomac River	† 816,840
Little Hunting Creek, Potomac River	† 3,549,520
Occoquan, Potomac River	† 4,879,970
Pohick, Potomac River	† 4,292,770
Total	† 84,024,250

ALEWIFE.

Disposition.	Number.
Maine: Damariscotta Mills, Damariscotta River	† 25,000

WHITEFISH.

Disposition.	Number.
Idaho: Fish Haven, Bear Lake	†1,295,000
Illinois: Spring Grove, State fish commission	*5,000,000
Michigan:	
Alpena, Lake Huron	†3,611,000
Cheboygan, Hammond Bay	†3,611,000
Crystal Falls, Anderson Lake	†240,000
Fortune Lake	†240,000
Detroit, Aquarium	*280,000
State fish commission	*20,000,000
Escanaba, Lake Michigan	†2,128,800
Gilchrist, Lake Michigan	†1,216,400
Gould City, Lake Michigan	†912,300
Houghton, Lake Superior	†3,750,000
Marquette, Lake Superior	†3,750,000
Norwood Reef, Lake Michigan	†3,000,000
St. Ignace, Lake Huron	†1,520,500
Sand Bay, Lake Michigan	†4,000,000
Minnesota:	
Duluth, Lake Superior	†10,000
Turner, Wilson Lake	†300,000
New York:	
Allan Otty Shoal, Lake Ontario	†560,000
Bear Point, Lake Onatrio	†4,300,000
Cape Vincent, State fish commission	*9,000,000
Charity Shoal, Lake Ontario	†900,000
Dutch Point, Lake Ontario	†3,250,000
East Charity Shoal, Lake Ontario	†200,000
Fox Island, Lake Ontario	†2,550,000
Fuller Bay, Lake Ontario	†3,150,000
Galloo Island, Lake Ontario	†875,000
Grenadier Island, Lake Ontario	†6,400,000
Hardscrabble Shoal, Lake Ontario	†100,000
Hayes Point, Lake Ontario	†525,000
Henderson Harbor, Lake Ontario	†3,150,000
Mud Creek Bay, Lake Ontario	†800,000
New York, Aquarium	*500,000
Niagara Falls, Niagara River	†750,000
Plattsburg, Lake Champlain	†750,000
Point Peninsula, Lake Ontario	†800,000
Port Henry, Lake Champlain	†400,000
Pulaski, Lake Ontario	†1,000,000

a Rescued from overflowed lands and restored to original waters.

Total Distribution of Fish and Fish Eggs, by Species, Fiscal Year 1919—Continued.

WHITEFISH—Continued.

Disposition.	Number.
New York—Continued.	
Rouses Point, Lake Champlain	†350,000
Three Mile Bay, Lake Ontario	†1,510,000
Tibbetts Point, Lake Ontario	†2,000,000
Van Schaick Shoal, Lake Ontario	†3,000,000
Watkins, Seneca Lake	†750,000
Wilson Bay, Lake Ontario	†4,350,000
Ohio:	
Isle St. George, Lake Erie	†6,300,000
Kelleys Island, Lake Erie	†25,000,000
Marblehead, Lake Erie	†10,000,000
North Bass, Lake Erie	†25,000,000
Port Clinton, Lake Erie	†15,000,000
Put in Bay, Lake Erie	†35,000,000
Ohio—Continued.	
Put in Bay, State fish commission	*10,800,000
Toledo, Lake Erie	†10,000,000
Pennsylvania: Erie, State fish commission	*37,070,000
Utah: Provo, Utah Lake	†200,000
Wisconsin:	
Amnicon River, Lake Superior	†210,000
Madison, State fish commission	*20,000,000
Canada: South Bay, Dominion of Canada	*9,000,000
Total	*111,650,000 †198,715,000

LAKE HERRING (CISCO).

Disposition.	Number.
New York:	
Allan Otty Shoal, Lake Ontario	†1,800,000
Bear Point, Lake Ontario	†7,900,000
Charity Shoal, Lake Ontario	†4,200,000
Dunkirk, State fish commission	*32,500,000
East Charity Shoal, Lake Ontario	†500,000
Fair Haven, Lake Ontario	†1,225,000
Fox Island, Lake Ontario	†9,400,000
Fuller Bay, Lake Ontario	†9,350,000
Galloo Island, Lake Ontario	†7,500,000
Grenadier Island, Lake Ontario	†14,800,000
Hayes Point, Lake Ontario	†540,000
Henderson Harbor, Lake Ontario	†1,320,000
Mud Creek Bay, Lake Ontario	†6,400,000
New York—Continued.	
Point Peninsula, Lake Ontario	†1,495,000
Three Mile Bay, Lake Ontario	†3,500,000
Tibbetts Point, Lake Ontario	†4,500,000
Van Schaick Shoal, Lake Ontario	†2,100,000
Wilson Bay, Lake Ontario	†9,650,000
Pennsylvania: Erie, State fish commission	*88,700,000
Canada: Kingsville, Canadian Government	*25,500,000
Total	*146,700,000 †86,180,000

SILVER SALMON.

Disposition.	Number.
Oregon:	
Applegate, Applegate Creek	491,650
Estacada, Clackamas River	2,200
Trail, Rogue River	97,500
Washington:	
Birdsview, Day Creek	15,000
Grandy Creek	†2,600,520 754,600
Brinnon, Walcotts Slough	55,000
Darrington, Bennetts Slough	†18,900
Duckabush, Duckabush River	153,380
Washington—Continued.	
Hamilton, Alder Creek	†2,087,000
Quilcene, Big Quilcene River	274,000
Little Quilcene River	80,000
Quinault, Quinault Lake	†600,000 419,400
Sultan, Elwell Creek	†2,157,600
Total	†7,464,020 2,345,730

CHINOOK SALMON.

Disposition.	Number.
California:	
Baird, McCloud River	2,280,000
Battle Creek, Battle Creek	4,509,000
Mill Creek, Mill Creek	3,498,800
Sisson, State fish commission	*11,802,500
New York:	
Allan Otty Shoal, Lake Ontario	†58,000
Cape Vincent, St. Lawrence River	†133,000
Carleton Island, St. Lawrence River	†59,300
Charity Shoals, Lake Ontario	†40,500 30,000
Dutch Point, Lake Ontario	8,500
Fox Island, Lake Ontario	†135,000 24,000
Fuller Bay, Lake Ontario	†35,000 15,000
Grenadier Island, Lake Ontario	†70,000 34,000
Hardscrabble, Lake Ontario	†33,000
Hayes Point, Lake Ontario	†28,800
Tibbetts Point, Lake Ontario	†35,000 5,000
Van Schaick Shoal, Lake Ontario	25,000
Wilson Bay, Lake Ontario	8,000
Oregon:	
Applegate, Applegate Creek	30,850
Clackamas, Clackamas River	2,981,000
Willamette River	100,000
Estacada, Clackamas River	889,500
River Mill, Clackamas River	322,000
Trail, Rogue River	1,003,100
Washington:	
Baker Lake, Baker Lake	86,500
Big White Salmon, Big White Salmon River	9,102,000
Birdsview, Alder Creek	55,000
Grandy Creek	†24,320 107,000
Little White Salmon, Little White Salmon River	9,177,500
Quilcene, Big Quilcene River	†18,250
Quinault, Quinault Lake	†100,000 109,400
Sultan, Elwell Creek	†246,430
Total	*11,802,500 †1,016,600 34,400,150

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

BLUEBACK SALMON.

Disposition.	Number.
Alaska:	
Afognak, Hatchery Creek	†3,971,000
Letnik Lake	†12,745,000 8,327,000
Yes Bay, Hatchery Creek	†26,650,000
Lake McDonald	8,679,700
Oregon: Bonneville, State fish commission	*3,440,100
Washington:	
Baker Lake, Baker Lake	8,622,000
Birdsview, Grandy Creek	45,560
Washington—Continued.	
Little White Salmon, Little White Salmon River	939,960
Quinault, Quinault Lake	†1,200,000 5,678,000
Canada: Frasier River, Canadian Government	*20,700,000
Total	*24,140,100 †39,756,000 37,642,220

HUMPBACK SALMON.

Disposition.	Number.
Alaska:	
Afognak, Hatchery Creek	†483,000
Letnik River	†1,659,000
Yes Bay, Hatchery Creek	†930,000
Washington:	
Birdsview, Grandy Creek	†1,969,000
Washington—Continued.	
Duckabush, Duckabush River	369,958
Quilcene, Big Quilcene River	†385,500
Total	†5,426,500 369,960

CHUM SALMON.

Disposition.	Number.
Washington:	
Birdsview, Grandy Creek	†848,840
Brinnon, Walcotts Slough	†1,850,000
Darrington, Bennetts Slough	†619,000
Duckabush, Duckabush River	†930,000 2,803,160
Little White Salmon, Little White Salmon River	†460,800
Washington—Continued.	
Quilcene, Big Quilcene River	†1,165,000 470,000
Little Quilcene River	†380,000 390,000
Total	†6,253,640 3,663,760

STEELHEAD SALMON.

Disposition.	Number.
Maine:	
Farmington, Clearwater Lake	1,011
Grand Lake, Grand Lake	34,938
Hiram, Hancock Brook	400
Otis, Green Lake	11,232
Massachusetts: Woronoco, Big Pond	1,300
Michigan:	
Charlevoix, Paddock Creek	†28,125
Pine Lake	24,358
Minnesota: St. Paul, State fish commission	*125,000
Nebraska:	
Alliance, Niobrara River	4,800
Andrews, Russell Lake	6,000
White River	9,000
New Jersey: Hackettstown, State fish commission	*25,000
New York:	
Albany, State fish commission	*200,000
Oakdale, applicant	*100,000
Pawling, Cow Pond	440
Hockey Pond	880
Port Henry, Lincoln Lake	4,500
Rosedale, Clear Creek	880
Tuxedo, applicant	*25,000
Oregon:	
Applegate, Applegate Creek	32,000
Clackamas, Clackamas River	5,000
Mecca, Shitike Creek	20,000
Trail, Rogue River	775,000
Upper Clackamas, Clackamas River	10,500
Vermont:	
Brattleboro, Newton Pond	1,000
Castleton, Lake St. Catherine	4,500
Holden, Chittenden Dam	10,086
Middlebury, Leicester River	4,500
Middlebury River	4,500
Readsboro, West River	600
Roxbury, State fish commission	*50,000
Washington:	
Birdsview, Grandy Creek	198,865
Quilcene, Big Quilcene River	170,000
Stevenson, Skamania County waters	*103,000
Sultan, Elwell Creek	92,500
Vancouver, Clarke County waters	*102,000
Washougal, Washougal River	†100,000
Yakima, Naches River	*25,000
Wyoming:	
Beulah, Miller Creek	2,500
Lander, Atlantic Lake	6,000
Harrison Lake	3,000
Lander Creek	3,000
Popo Agie River	6,000
Silas Lake	3,000
Rock Springs, Fremont Lake	20,000
Saratoga, Upper Lake Creek	5,000
North Platte River	16,000
Sheridan, State fish commission	*50,000
Total	*805,000 †128,125 1,493,290

Total Distribution of Fish and Fish Eggs, by Species, Fiscal Year 1919—Continued.

ATLANTIC SALMON.

Disposition.	Number.
Maine:	
Blanchard, Piscataqua River	†52,500
Salmon Brook	†52,500
Brownville, Pleasant River	†325,500
Cherryfield, Narraguagus River	†437,500
Columbia Falls, Pleasant River	†437,500
Dennysville, Dennys River	†437,500
Dover, Sebec Lake	†52,500
Grindstone, Penobscot River, East Branch	†194,400
Katahdin Iron Works, Pleasant River	†52,500
Maine—Continued.	
Monson, Davis Stream	†52,500
Oakfield, Mattawamkeag River, East Branch	†243,100
Orland, Orland River	700
Shirley, Piscataqua River, West Branch	†52,000
Total	†2,390,000 700

LANDLOCKED SALMON.

Disposition.	Number.
Maine:	
Belgrade, Great Lake	†6,000
Brooks, Passagassawaukee Lake	†6,000
Brownfield, Burt Meadow Pond	†2,400
Caribou, State fish commission	*405,127
Danforth, Grand Lake	†24,000
Dedham, Green Lake	32,000
Dexter, Lake Wassookeag	†6,000
Main Brook	†10,500
Puffer Pond	†6,000
East Orland, Toddy Pond	†69,925
Ellsworth, Beech Hill Lake	†10,500
Farmington, Clearwater Lake	†6,000
Crystal Lake	†6,000
Forest, Farrar Lake	†6,000
Franklin, Molasses Pond	†20,000
Grand Lake Stream, Dobsis Lake	†7,500 17,000
Grand Lake	†11,445 28,738
Guilford, Piper Pond	†6,000
Hartland, Great Moose Lake	†15,000
Holeb, Holeb Lake	†3,000
Houlton, Drews Lake	†12,000
Indian Landing, Indian Landing Brook	†7,000
Island Falls, Mattawamkeag Lake	†10,500
Jackman, Lake Wood	†5,000
Kineo Station, Moosehead Lake	†7,500
Moose River	†5,000
Lambert Lake, Lambert Lake	†10,500
Livermore Falls, Basin Pond	†3,000
Nicolin, Nicolin Lake	†10,000
North Anson, Embden Pond	†9,000
Norway, Virginia Lake	19
Otis, Green Lake	58,443
Ox Brook, Ox Brook Stream	10,000
Pembroke, Boyden Lake	†8,000
Pork Barrel Brook, Pork Barrel Brook	10,000
Maine—Continued.	
Princeton, Big Lake	†10,500
Grand Falls Pond	†6,000
Sebago Lake, Sebago Lake	†9,600
Stockholm, Square Lake	†18,000
Walkers, Squa Pan Lake	†9,000
Webster, Chemo Lake	†7,500
New Hampshire:	
Bristol, Newfound Lake	456
Canaan, Clark Pond	†1,000
Cumming Pond	†1,000
Lyne Pond	800
Sweet Pond	800
Tewksbury Pond	800
Colebrook, Diamond Pond	†2,400
Harrisville, Long Pond	5,000
Laconia, Winnisquam Lake	6,000
Newport, Cold Pond	5,000
Potter Place, Pleasant Lake	5,400
New York:	
Forestport, Honnedaga Lake	†6,000
Nehasane, Big Rock Lake	†3,000
Lake Lila	†4,500
North Creek, Moose Pond	†3,000
Newcomb Lake	†3,000
Port Henry, Lincoln Lake	†6,000
Port Jervis, Cahoonzie Lake	400
Thurman, State fish commission	†15,000
Vermont:	
Beecher Falls, Connecticut Lake	†2,400
Canaan, Big Averill Lake	†3,600 500
Little Averill Lake	†3,600 300
Newport, Salem Pond	300
Orleans, Willoughby Lake	600
Total [a]	*405,125 †424,870 182,560

RAINBOW TROUT.

Disposition.	Number.
Alabama: Munford, Salt Creek	7,200
Arizona:	
Ash Fork, Chino Creek	2,000
Sycamore Creek	2,000
Benson, Kiper's Pond	5,000
Clarkdale, Black Canyon Creek	2,000
Globe, Ash Creek	10,000
Grand Canyon, Hermit Creek	2,000
Tempe, Salt River	3,000
Arkansas:	
Cravette, Spavins Creek	1,685
Decatur, Spring Creek Pond	500
Harrison, Buffalo River	1,500
Crooked Creek	9,000
Long Creek	7,800
Rogers, Spout Springs Pond	100
Arkansas—Continued.	
Saint Joe, Richland Creek	1,200
Tomahawk Creek	3,000
Colorado:	
Alma, Lake Emma	3,000
Basalt, Frying Pan River	1,000
Bear Creek, Bear Creek	1,000
Buffalo, Wigwam Creek	1,000
Cebolla, Cebolla Creek	1,000
East Elk Creek	1,000
Gunnison River	1,000
Cimarron, Little Cimarron River	1,000
Colorado Springs, Cheyenne Lake	2,000
Cotopaxi, Lake Creek Lake	2,000
Spruce Creek Lake	1,000
Creede, Rio Grande River	2,000

[a] Exclusive of 7,000 fry lost in transit.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

RAINBOW TROUT—Continued.

Disposition.	Number.	Disposition.	Number.
Colorado—Continued.		Kentucky:	
Denver, Bear Creek	1,000	Bowling Green, Drakes Creek	4,050
Durango, Cascade Creek	1,500	Jennings Creek	115
Hermosa Creek	1,500	South Union, Clear Creek	85
Potato Lake	1,000	Maine: Portland, Pleasant River	800
Edwards, Eagle River	2,000	Maryland:	
Lake Creek	2,000	Baltimore, State fish commission	*50,000
Fairplay, South Platte River	3,000	Brown, Turkey Branch	4,000
Fort Collins, Cache La Poudre River	2,000	Carrollton, Greens Run	600
Gunnison, South Beaver Creek	1,000	Friendsville, Savages Pond	700
Tomichi Creek	1,000	Kensington, Cedar Pond	500
Hillside, Dismore Creek Ponds	4,000	Oakland, Big Youghiogheny River	2,100
Leadville, Evergreen Lake	10,000	Muddy Creek	1,400
Half Moon Creek	1,000	Rawlings, Mill Creek	1,400
Turquoise Lake	15,000	Ruxton, Callendar House Pond	500
Loveland, Big Thompson River and branches	5,000	Takoma Park, Sligo Creek	300
Buckhorn River	1,000	Massachusetts:	
Buckhorn River, North Fork	1,000	Athol, Lake Ellis	†3,000
Cedar Creek	1,000	Great Barrington, Williams River	†1,500
Cow Creek	1,000	Lowell, Burgess Pond	600
Fox Creek	1,000	Forge Pond	700
Mullin Fork Creek	1,000	Long Pond	700
North Creek	1,000	Long Sought For Pond	700
West Creek	1,000	Spectacle Pond	600
Lyons, North St. Vrain Creek	1,000	Woronoco, Big Pond	†6,000
Ouray, Lake Lenore	2,000	Michigan:	
Parlin, Tomichi Creek	1,000	Amasa, Little Hemlock River	300
Parshall, Grand River	2,000	Bessemer, Pine Creek	300
Puzzler, Forest Lake	500	Powder Mill Creek, East Branch	300
Ruedi, Ruedi Lake	1,000	Buchanan, McCoyes Creek	†2,000
Salida, Little Cochetopa Creek	1,000	Sampson Creek	†2,000
Marshall Creek	2,000	Crystal Falls, Michigamme River	2,400
Poncha Creek	2,000	Paint River	300
Sapinero, Gunnison River	1,000	Grayling, Tillula Lake	8,000
Soap Creek	1,000	Houghton, Dees Pond	1,750
Snowmass, Capitol Creek	1,500	Lake Paine	1,200
Sopris Creek	1,500	Redridge Lake	1,800
Woody Creek	1,500	Indian River, Sturgeon River	2,000
Steamboat Springs, Maida Dawn Lake	1,000	Iron River, Paint River	300
Sulphur Springs, Big Slough Pond	1,000	Marquette, Bagdad Lake	150
Deep Slough Pond	1,000	Niles, Dowagiac Creek	†4,000
Grand River	2,000	Madison Creek	†2,000
Tabernash, Ranch Creek	1,000	Pokagon Creek	†2,000
Tolland, Newcomb Creek	1,000	Summerville Creek	†2,000
West South Boulder Creek	1,000	Petersburg, Crystal Pond	1,000
Trinidad, Purgatory River, Middle Fork	3,000	Petosky, Heber Creek	4,000
Troublesome, Birdseye Creek	1,000	Republic, Black River	400
Cold Water Creek	1,000	Stambaugh, Bush Creek	300
Troublesome Creek	1,000	Traverse City, Boardman River	4,000
Walsenburg, Orchard Lake	1,000	Shelby, Powers pond	1,000
Wasatch, Beaver Dam Lake	1,000	Sidnaw, Sidnaw Creek	3,600
Clear Lake	1,000	Six Lakes, Flat River	2,000
Woodland Park, Bear Lake	2,000	Wakefield, Jackson Creek, West Branch	2,400
Northfield Lake	3,000	Minnesota:	
Georgia:		Bemidje, Burdette Creek	1,034
Dillard, Beanert Creek	2,500	Deep Lake	1,133
Helen, Chalahoochie River	15,000	Caledonia, Crooked Creek	450
Lakemont, Tiger Creek	2,000	Crooked Creek, South Fork	450
Rabun Gap, Bettys Creek	2,500	Crystal Valley Creek	450
Rome, Mountain Lake	3,600	Dexter Creek	450
Idaho:		East Beaver Creek	450
Ashton, Sand Creek	2,500	Thompson Creek	450
Boise, Arrowrock Lake	17,000	West Beaver Creek	450
Fish Haven, Bear Lake	1,000	Winnebago Creek	450
Payette, Shamberger's pond	6,000	Clearbrook, Falk Lake	1,133
Pocatello, Rabbit Creek	28,000	Dover, Bear Creek	1,700
Sand Point, State fish commission	*50,000	Cascade Creek	2,125
Spencer, applicant	*25,000	North Branch	1,000
Iowa:		Ely, Garden Lake	3,000
Cedar Rapids, applicant	*2,000	Lewiston, Enterprise Creek	850
McLeod Springs Pond	400	Hemingway Creek	850
Jackson Junction, Goddard Creek	2,000	Whitewater Creek, Middle Branch	1,275
Lansing, State fish commission	*70,000	Whitewater Creek, South Branch	1,700
Manchester, Spring Branch	2,800	Minneapolis, Nine Mile Creek	1,700
North McGregor, Bloody Run	1,275	Nine Mile Creek, Right Branch	1,275
Giard Creek	3,250	Minnesota City, Bear Creek	850
		Middle Valley Creek	850
		Rupprechts Creek	850

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

RAINBOW TROUT—Continued.

Disposition.	Number.
Minnesota—Continued.	
Minnesota City, Speltz Valley Creek	1,275
Pillager, Peterson Creek	1,275
Plainview, Wattewater River, North Branch	3,000
Preston, Camp Creek	850
North Branch	425
Partridge Creek	425
South Branch	425
Spring Creek	425
Trout Run Creek	425
Watson Creek	850
Willow Creek	850
Rushford, Beaver Creek	425
Cooledge Creek	425
Daley Creek	425
Enterprise Creek	425
Ferguson Creek	425
Gribbin Creek	425
Hazzard Creek	425
Hemingway Creek	425
Meade Creek	425
Onstine Creek	425
Opheim Creek	425
Overland Creek	425
Pine Creek	850
Rush Creek	850
Trout Run Creek	850
West Beaver Creek	425
St. Paul, State fish commission	*50,000
Stockton, Stockton Creek	850
Stockton Creek, East Branch	850
Stockton Creek, South Branch	1,275
Straight Valley Creek	850
Winona, Big Trout Creek	1,275
Cedar Creek	1,275
East Burns Valley Creek	1,275
Harvey Creek	1,275
Hicks Valley Creek	850
Little Trout Creek	850
Morey Creek	1,275
Morrison Creek	425
Murray Valley Creek	850
Pine Creek	425
Pleasant Valley Creek	850
Wiscoy Creek	850
Missouri:	
Aurora, Spring River	10,000
Crane, Crane Creek	1,600
Greer, Greer Springs Creek	10,000
Joplin, Arrowhead Lake	300
Spring Pond	100
Lebonon, Ha Ha Tonka Lake	12,000
Neosho, Capps Creek	5,000
Hickory Creek	2,051
Momahon Spring Creek	430
Newburg, Yancey Mill Lake	6,000
Pierce City, Shoal Creek	10,000
Quail Spur, McCord Branch	10,000
Rolla, Little Piney Creek	8,000
St. James, Meramec Creek	4,000
Seligman, Mint Spring Pond	8,000
Verona, Spring River	800
Wayne, Roaring River	1,200
Mikes Creek	1,200
Montana:	
Anaconda, State fish commission	*1,000,000
Belgrade, Cottonwood Creek	16,000
Billings, Andersen's pond	2,000
Spring Creek	4,000
Bozeman, Asbestos Creek	2,000
Brackett Creek	2,000
Bridger Creek	8,000
Buck Creek	2,000
Dailey Creek	2,000
East Bear Creek	6,000
Fish Creek	4,000
Lake Alva	10,000
Lava Lake	2,000
Montana—Continued.	
Bozeman, Middle Creek	10,000
North Cottonwood Creek	2,000
North Twin Lake	2,000
Ole Olson Lake	2,000
Pass Creek	2,000
Pine Creek	2,000
Reese Creek	2,000
Rocky Creek	2,000
Ross Creek	10,000
Sage Creek	2,000
Sales Creek	2,000
Sixteen Mile Creek	2,000
Sour Dough Creek	8,000
South Meadow Creek	2,000
South Taylor Creek	2,000
South Twin Lake	2,000
Specimen Creek	2,000
Spring Hill Creek	2,000
Stony Lake	2,000
Sun River, North Fork	50,000
Taylor Creek	2,000
Teepe Creek	2,000
Thomas Creek	8,000
West Bear Creek	2,000
Butte, Big Hole River	*230,000
Darby, Rye Creek Ponds	3,750
Forest Grove, Bear Creek	1,500
McDonald Creek, South Fork	10,500
Harlowton, Agnes Creek	1,500
American Forks Creek	2,250
Big Elk Creek	2,250
Careless Creek	2,250
Crooked Creek	2,250
Daisy Dean Creek	2,250
Fish Creek	2,250
Haymaker Creek	2,250
Hopley Creek	6,000
Lebo Creek	2,250
Lebo Lake	2,250
Little Elk Creek	2,250
Little Spring Creek	1,500
McVey Creek	1,500
Meadow Creek	1,500
Mexican John Creek	2,250
Miller Creek	2,250
Muddy Creek	1,500
Musselshell River	2,250
Spring Creek	3,000
Swimming Woman Creek	2,250
Lennep, Allebaugh Creek	2,250
Castle Creek	2,250
Comb Creek	2,250
Coyote Creek	3,000
Hensley Creek	2,250
Musselshell River, South Fork	2,250
Robinson Creek	2,250
Libby, Bootjack Lake	5,000
Martinsdale, Checkerboard Creek	3,000
Cottonwood Creek	1,500
Cottonwood Lake	2,250
Du Rand Lake	1,500
Flagstaff Creek	1,500
Musselshell River, North Fork	2,250
Spring Creek	12,000
Missoula, Belmont Creek	4,000
Blackfoot River	6,000
Blackfoot River, North Fork	8,000
Clearwater River	6,000
Cottonwood Lake	2,000
Crow Creek	4,000
Elbow Lake	8,000
Elk Creek	4,000
Lake Inez	10,000
Mission Creek	4,000
Nine Mile Creek	4,000
Owl Creek	6,000
Placid Lake	10,000
Post Creek	4,000

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

RAINBOW TROUT—Continued.

Disposition.	Number.
Montana—Continued.	
Missoula, Rock Creek	14,000
Seeley Lake	10,000
Norris, Madison Lake and tributaries	48,000
Meadow Creek	48,000
Ravalla, Would Fish Lake	8,000
Townsend, Crow Creek	12,000
Deep Creek	12,000
Spring Creek	10,500
Whitefish, Beaver Lake	7,500
Whitefish Lake	23,750
Whitefish River	10,000
White Suplhur Springs, Sheep Creek	14,000
Smith River	10,000
Winston, Meyers pond	1,500
Yellowstone, Lower Grayling Creek	7,500
Madison Creek, South Fork	10,500
Nebraska:	
Andrews, Russel Ranch Lake	1,400
White River	7,000
Chadron, Ash Creek	2,800
Beaver Creek	2,100
Chadron Creek	2,800
Trunk Butte Creek	2,100
Colclesser, Pine Creek	2,520
Crawford, White River	1,400
Glenn, White River	8,000
Gordon, Snake River	3,500
Nevada:	
Ely, State fish commission	*25,000
Verdi, Truckee River	*25,000
New Hampshire:	
Lebanon, Cole Pond	4,000
Nashua, Silver Lake	2,224
Newport, Sugar River	2,000
Pike, Lake Christine	†6,000
Suncook, Hampshire Brook	300
Kenison Brook	300
Moores Brook	300
New Jersey:	
Crawford, Rahway River	3,600
Hackettstown, State fish commission	*35,000
Oak Ridge, Stony Brook Lake	600
New Mexico:	
Bernalillo, Los Huertos Creek	2,000
Carizoza, Eagle Creek	2,000
Chama, Brazos River	2,000
Chama River	3,000
Chavez Creek	2,000
Nutritas Creek	3,000
Cimarron, Urracca Lake	2,000
East Las Vegas, Coyote River	6,000
Gallinas River and branches	5,000
Lujon Valley Creek	2,000
Mora River	3,000
Rio de La Casa	6,000
Rio de Las Lunas and branches	4,000
Tecolote Creek	3,000
Stewart Lake	1,000
High Rolls, Fresnal Creek	1,000
Mountainair, Tajique Creek	2,000
Perea, Los Nutrias Creek	4,000
Santa Fe, Santa Fe Lake	2,000
Taos Junction, Ben Hur Lake	1,000
Water Bird Lake	2,000
Tularosa, Rio Tularosa	1,000
Ute Park, Cimarron River	3,000
New York:	
Ardsley, Sawmill River	3,000
Batavia, Goulds Brook	2,600
Benson Mines, Twin Lakes	2,600
Deposit, Oquaga Creek	3,900
Summit Creek	3,900
Trout Creek	3,900
Elmira, South Creek	3,900
Genoa, Little Salmon Creek	2,600
Hornell, Big Creek	3,900
Canacadea Creek	3,900
New York—Continued.	
Hornell, Canisteo Creek	3,900
Canisteo River	5,200
Carr Valley Brook	2,600
Seeley Creek	2,600
Hunter, Schoharie River	5,200
Ilion, Millers Mill Creek	5,200
Ithaca, Enfield Creek	3,900
Napanock, Youngs Ponds	1,300
New York, Aquarium	*5,000
North Lansing, Nelson Metzar Creek	2,600
Salmon Creek	2,600
Oneida, Cowasselon Creek	3,900
Oneida Creek	3,900
Sconondoa Creek	3,900
Racquette Lake, Lake Mohegan	*25,000
Shekomeko, Pugsley Hill Creek	1,500
Syracuse, Butternut Creek	7,800
Limestone Creek	9,100
Trumansburg, Mecklenburg Creek	2,600
Reynoldsville Creek	2,600
Watertown, Black Creek	6,500
Hubbard Creek	3,900
Wellsville, Brimmer Creek	2,600
Cryder Creek	2,600
Dykes Creek	2,600
Fords Creek	1,300
Fulmer Valley Creek	2,600
Genessee River	2,600
Knights Creek	1,300
Marsh Creek	1,300
Pikeville Creek	2,600
Vandermark Creek	2,600
North Carolina:	
Bessemer City, Toms Creek Lake	10,000
Black Mountain, Long Branch	4,000
Swannanoa River, North Fork	10,000
Swannanoa River, Sugar Fork	4,000
Boone, Howard Creek	1,000
Cranberry, Blevins Creek	1,000
Ela, Cooper Creek	4,000
Little Creek	4,000
Newton Mill Creek	4,000
Elk Park, Blevins Creek	15,000
Elk River	3,600
Little Elk Creek	8,400
Franklin, Rabbit Creek	3,750
Green Mountain, Toe River	4,500
Horseshoe, Mills River	7,000
Hot Springs, Little Creek	6,000
Long Branch	4,000
Lansing, Big Horse Creek	4,000
Little Horse Creek	3,500
Lenoir, Gragg Creek	2,000
Rock House Creek	1,000
Wilson Creek	2,500
Yadkin River	6,000
Linville Falls, Linville River	1,500
Marshville, Thomas Pond	5,000
Micaville, Locust Creek	6,000
South Toe River	10,500
Montezuma, Lindville River	5,000
North Wilkesboro, Reddies River	7,200
Pickens, Estatoe Creek	7,500
Whitewater River	7,500
Poplar, Flat Branch	4,500
Spruce Pine, Grassy Creek	4,000
Tuxedo, Cabin Creek	6,250
Green River	16,250
Rock Creek	3,750
Waynesville, McElroy Creek	4,000
North Dakota: Fullerton, Maple River	640
Ohio: Middlefield, Orchard Pond	1,000
Oklahoma: Oklahoma City, State fish commission	7,800
Oregon:	
Booneville, State fish commission	*765,120
Clackamas, Spring Creek	5,000

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

RAINBOW TROUT—Continued.

Disposition.	Number.
Oregon—Continued.	
La Grande, Catherine Creek	25,000
Fern Springs Pond	1,000
Lake Union	5,000
Meacham Creek	7,500
Powder River	7,500
Mecca, Shitike Creek	10,000
Warm Springs River	10,000
Medford, Crater Lake	20,000
Oregon City, Clackamas River	20,000
Trail, Rogue River	28,000
Pennsylvania;	
Cedar Hollow, Valley Creek and branches	2,400
Coburn, Elk Creek	2,000
Penns Creek	2,000
Coudersport, Allen Creek	800
Bly Run	600
Carmer Run	1,000
Cold Spring Run	600
Cole Run	800
Coyal Creek	600
Crouch Run	1,000
Davis Run	600
Estes Run	800
Hilliger Creek	600
Kenyon Creek	1,000
Netzgar Creek	1,000
Reeves Run	600
Salter Creek	800
Sherwood Branch	600
Short Run	1,000
South Branch	2,000
Stevens Run	600
Swoft Run	600
Whitney Creek	2,000
Whitney Creek, East Branch	1,000
Whitney Creek, West Branch	1,000
Woodard Run	600
Ebensburg, Roaring Run	1,000
Gouldsboro, Lehigh River	4,200
Hamburg, Maiden Creek	1,800
Pine Creek	1,200
Hoadleys, Middle Creek	1,800
Hollidaysburg, Cave Run	1,400
Honesdale, Everhart Run	1,800
Howellville, Valley Creek and branches	3,000
Hydetown, Anderson Run	400
Carroll Run	400
Dunham Run	400
Fenton Run	400
Glen Run	400
Hummer Run	400
McLaughlin Run	400
Mooley Run	400
Morris Run	400
Shirley Run	400
Stony Hollow Run	400
Tubbs Run	400
Indian Head, Camp Run	600
Indian Creek	600
Mountain Run	400
Ivyland, Pleasant Plains Pond	600
Jersey Shore, Larrys Creek	1,600
Johnstown, Alwine Run	400
Baker Run	400
Bens Creek and branches	1,200
Big Mill Creek	400
Big Spring Run	400
Canfield Run	400
Card Machine Run	400
Clear Shade Creek	400
Dalton Run	400
Henaries Creek	400
Hinckson Run	400
Johns Mill Run	400
Laurel Run (A)	400
Laurel Run (B)	400
Pennsylvania—Continued.	
Johnstown, Mill Creek	400
Miller Run	400
Mishler Run	400
Pickens Run	400
Powder Mill Run	400
Richer Run	400
Roaring Run	400
Salt Lick Run	400
Shannon Run	400
Sugar Run	400
Tub Mill Run	400
King of Prussia, Trout Creek and branches	2,400
Listonburg, Whites Creek	4,400
Mance, Wills Creek	6,000
Marietta, Shooks Mills Creek	3,000
Mill Hall, Fishing Creek	4,200
Heards Creek	700
Long Run	2,100
Mill Lane, Valley Creek	3,600
New Centerville, Gulph Creek and branches	2,400
Trout Creek and branches	2,400
New Ringgold, Cold Run	1,200
Oil City, Hemlock Creek	2,800
Norway Run	1,400
Porcupine Run	2,100
Paoli Roads, Valley Creek and branches	1,800
Pittston, Poor House Creek	3,600
Spring Run	7,800
Ralphton, Quemahoning Creek, North Branch	1,200
Renova, Drurys Run	1,000
Hyner Run	1,200
Ringtown, Dark Run	1,200
Girard Pond	1,200
Little Catawissa Creek	1,200
Trexler Run	1,200
St. Peters, Rock Run	1,800
Smithfield, Mill Run	2,100
Somerset, Beans Run	1,200
Blue Hole Run	1,200
Kimberly Run	1,200
Milford Creek	1,200
Trout Run, Four Mile Run	500
Grays Run	500
Lycoming Creek	500
Six Mile Run	500
Trout Run	500
Uniontown, Big Sandy Creek	800
Seaton Lake	800
Waterville, Dam Run	500
Little Pine Creek	500
Long Fork Creek	500
Lower English Run	500
Otter Run	500
Sebring Creek	500
Williamsport, Mill Creek	500
Scotch Mill Creek	500
Sugar Camp Run	500
Waller Run	500
Windber, Big Paint Creek	1,400
Dark Shade Creek	700
Little Paint Creek	1,400
Little South Fork Run	2,100
Piney Run	1,400
Shade Creek	700
Sienna Run	2,100
Tub Run	700
Wentz Run	1,400
South Dakota:	
Buffalo Gap, Beaver Creek	10,000
Custer, Dolls Pond	600
Englewood, Ward Creek	1,200
Fruitdale, Park Spring Branch	500
Hill City, Spring Creek	16,800
Merriman, Lake Creek Pond	2,000

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

RAINBOW TROUT—Continued.

Disposition.	Number.
South Dakota—Continued.	
Mystic, Little Rapid Creek	3,600
Newell, Kirby Lake	1,200
Pine Ridge, Spring Creek	1,640
Yellow Thunder Creek	1,640
Rapid City, Barker Pond	2,800
Box Elder Creek	2,250
Cottonwood Lake	2,800
Keenan Pond	500
Lower Box Elder Creek	2,250
Minnelusa Creek	1,700
Rapid Creek	2,250
Schambers Creek	700
Scott Pond	2,800
Spring Canyon Creek	2,100
Victoria Creek	2,100
Spearfish, Chicken Creek	3,500
Cold Spring Creek	840
Coxes Lake	2,100
Hilton Gulch Creek	4,000
Hulls Branch	840
Oak Creek	700
Riverview Branch	1,400
Stannus's pond	560
State fish commission	50,000
Stucco Creek	700
Summers's pond	700
Wears Branch	1,400
Webb Knight Branch	6,000
Sturgis, Bear Butte Creek	11,100
Morse Pond	1,000
Spring Draw Creek	500
Waterworks Lake	6,000
Tilford, Morris Creek Pond	500
Vale, Cottonwood Creek	8,000
Wall, Miller Reservoir	500
Tennessee:	
Chattanooga, Rainbow Lake	3,000
Crabtree, Roaring Creek	1,000
Elkmont, Little River	13,000
State fish commission	*42,700
Erwin, Birchfield Creek	5,400
Birchfield Pond	5,800
North Indian Creek	20,400
Rock Creek	6,000
Etowah, Bullet Creek	500
Farner, Conasauga Creek	10,000
Turtletown Creek	10,000
Greenville, Nolachucky River	4,500
Paint Creek	4,500
McFarland, Big Lost Creek	9,000
Lost Creek	6,000
Maryville, Sycamore Pond	6,000
Sevierville, Little Pigeon River	20,000
Somerville, Loosahatchie River	8,000
Tellico Plains, Lake Tellico	1,200
Wartrace, Ellwood Pond	2,000
Utah:	
Lehi, Mill Pond	3,900
Logan, Hyde Park Ponds	1,125
Logan River	1,125
Murray, Froiseth's pond	1,500
Ogden, Lofgren's pond	500
Mill Pond	400
Read's pond	1,000
Winter's pond	600
Provo, Provo River	10,000
Springville, Hobble Creek	10,000
Spring Creek	277,500
Vermont: Groton, Wells River	†8,000
Virginia:	
Abingdon, streams along Va.-Car.Ry.	51,500
Alleghany, Sweet Chalybeate Creek	12,000
Atkins, Smider-Murror Pond	500
Blacksburg, Big Run Creek	500
Boone Mill, Boon's pond	200
Buchanan, Purgatory Creek	2,000
Buena Vista, Hollow Branch	8,000
Byllesby, Chestnut Creek	7,000
Virginia—Continued.	
Charlottesville, Tiverton Branch	3,000
Dillwyn, Eldridge Pond	650
East Falls Church, Holmes Run	150
Four Mile Run	150
Fairwood, Wilson Creek	11,900
Lorton, Charles Run	400
Marion, Holston Creek	1,000
Narrows, Dry Branch	3,000
Kimberling Creek	3,000
Natural Bridge, Crawford Creek	8,000
Pearisburg, Clendennin Creek	4,000
Ding Branch	2,000
Mill Creek	4,500
Nobusiness Creek	2,000
Pemberton, Little Beal Creek	2,000
Pembroke, Little Stony Creek	1,500
Pohick, Pohick Creek	6,000
Purcelle, Reed Creek	6,000
Speedwell, Peach Bottom Creek	1,600
Stuart Draft, Coles Run	1,200
Sugar Grove, Dickey Creek	4,200
Teas, Holston River, South Branch	28,000
Timber Ridge, Lackey's pond	1,000
Trout Dale, Fox Creek	22,500
Laurel Creek	3,500
Pierce Creek	4,200
Pugh Creek	2,800
Ripshine Creek	2,800
Staley Creek	5,600
Wallace, Beaver Creek	1,500
White Top Gap, Burgess Creek	1,500
Wilda, South River	9,000
Washington:	
Boyds, Sherwood Creek	10,000
Colville, County Game Commission	*50,000
Lind, York Lake	10,000
Moab, Newman Lake	12,000
Montesamo, Satsop River	12,000
Orient, Meadow Lake	8,000
Republic, Deep Lake	14,000
Tacoma, Clear Lake	7,500
Vancouver, Battle Grounds Lake	*50,000
Walla Walla, Ford's pond	300
West Virginia:	
Bemis, Cheat River, Shavers Fork	1,000
Berkeley Springs, Brushy Fork Run	2,800
Fayette, Wolf Creek	800
Hazleton, Beaver Creek	2,100
Martinsburg, Tuscarora Creek	3,500
Mill Creek, Tygarts Valley River and branches	9,000
Richwood, Big Laurel Creek	12,000
Cranberry River	8,000
Terra Alta, Dority Creek	1,400
Thomas, Boyer's pond	800
Leadmine Creek	1,500
Wolf Run	2,000
Webster Springs, Gauley River	4,800
White Sulphur Springs, Howard Creek	10,250
Wisconsin:	
Aniwa, Plover River	300
Arcadia, American Valley Creek	450
Davis Valley Creek	1,000
English Creek	675
Glencoe Creek	1,450
Lewis Valley Creek	1,675
North Branch Creek	1,000
Rainy Valley Creek	1,000
Riley Creek	1,000
Stony Creek	1,000
Tompson Valley Creek	1,000
Travis Creek	1,000
Trout Creek	450
Waumandee Creek	1,000
Zellers Creek	1,000
Athens, Black Creek	3,000
Bangor, Brush Hollow Creek	600

Total Distribution of Fish and Fish Eggs, by Species, Fiscal Year 1919—Continued.

RAINBOW TROUT—Continued.

Disposition.	Number.
Wisconsin—Continued.	
Black River Falls, Allen Creek	900
Robinson Creek	1,125
Blue Mounds, Bohoris Creek	2,000
Frames Creek	1,000
McKinley Creek	1,000
Royjacks Creek	1,000
Ryans Creek	1,000
Topper Creek	1,000
Brule, Brule River	6,000
Little Brule River	2,400
McDougal Lake	3,000
Chippewa Falls, Duncan Creek	1,800
Paint Creek	1,800
Couderay, Devils Creek	2,000
Eddy Creek	1,000
Hay Creek	1,000
King Creek	2,000
Squaw Creek	2,000
Windfall Creek	2,000
Donaldson, Big Tamarack Creek	200
Black Oak Lake	600
Little Tamarack Creek	200
Mill Creek	200
Pickerel Creek	1,400
Portage Creek	2,800
Spring Creek	200
Ettrick, Affeldts Creek	850
Beaver Creek, South Branch	1,700
Langs Creek	850
Larsons Creek	850
McConnon Creek	425
Olson Creek	425
Fond du Lac, Brownsville Creek	100
Camp Ground Creek	200
Gillett Creek	100
Milwaukee River	100
Parson Creek	100
St. Cloud Creek	100
Silver Creek	100
Woolen Mill Creek	100
Hawthorne, Three Buck Lake	2,000
Independence, Bennett Creek	675
Cooke Creek	675
Haakenson Creek	675
Solfest Creek	675
Traverse Creek	675
Wickham Creek	675
Ladysmith, Hemlock River	1,800
Laona, Peshtigo River	300
Lavalle, Carr Valley Creek	675
Jenson Creek	1,125
Maiden Rock, Lost Creek	1,125
Travis Spring Creek	900
Minocqua, Johnson Creek	1,200
Norwalk, Brieske Creek	500
Buckholz Creek	500
Dreier Creek	1,000
Fairbanks Creek	500
Felz Creek	1,900
Halderman Creek	500
Hidden Creek	500
Kraeger Creek	500
Pine Creek	500
Rice Creek	1,000
Rock Creek	1,000
Schell Creek	500
Spring Creek	900
Tar Creek	1,000
Woodliff Creek	1,000
Zitlow Creek	1,000
Oakfield, Fond du Lac River	400
Pembine, Paulson Creek	200
Smith Creek	300
Trestle Creek	300
Rice Lake, Long Lake Creek	2,400
Red Cedar River	2,400
Spring Creek	1,200
Yellow River	1,800
River Falls, Kinnickinnick River	3,600
Wisconsin—Continued.	
River Falls, Kinnickinnick River, Corcoran Branch	1,200
Rocky Branch	1,200
Salmo, Raspberry Creek	900
Sioux River	900
Solon Springs, Moose River	1,800
Stanley, Scovins Creek	600
Stone Lake, Hovey Lake	1,800
Tigerton, Steinke Creek	300
Tomahawk, Armstrong Creek	450
Lanweh Creek	675
Pickerel Creek	675
Rickie Creek	675
Spirit River, Middle Fork	675
Spirit River, North Fork	675
Spirit River, South Fork	675
Waukesha, Genesee Creek	5,000
Jerico Creek	3,000
Sorensen Creek	1,000
Wales Creek	2,000
Waterville Creek	4,000
Waupaca, Chain of Lakes	500
Hartman Creek	2,000
Little Wolf River, South Branch	6,400
Westby, Aarnes Creek	500
Bakkin Creek	500
Black Bottom Creek	500
Boggs Creek	500
Bohemian Creek	500
Brookville Creek	500
Brush Creek	500
Cannon Valley Creek	500
Clark Creek	500
Clements Creek	500
Duck Egg Creek	500
Esofea Creek	500
Freming Creek	1,000
Goplen Creek	1,000
Hagen Creek	500
Hanson Creek	500
Harrison Creek	500
Hay Creek	500
Hornby Creek	500
Jensen Creek	1,000
Jugg Creek	500
Kickapoo River, West Fork	500
Knapp Creek	500
Laugher Creek	500
Lunde Creek	500
McGeary Creek	500
Miner Creek	500
Norlinsky Creek	500
North Bear Creek	500
North Billings Creek	500
Oium Creek	500
Otter Creek	500
Paulsrud Creek	500
Rudrud Creek	500
Ruland Creek	500
Sandbakken Creek	500
Seas Creek	500
Sending Creek	500
Sherve Creek	500
Sidie Creek	500
Simonson Creek	1,000
Skaug Creek	500
South Bear Creek	500
South Billings Creek	500
Spillman Creek	500
Sveum Creek	500
Swenson Creek	1,000
Thorson Creek	500
Timber Coulee Creek	1,000
Twenty-Four Valley Creek	500
Van Ruden Creek	1,000
Weaster Creek	500
Wyoming:	
Alladdin, Caldwell's pond	3,000
Beulah, La Plant Creek	8,000

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

RAINBOW TROUT—Continued.

Disposition.	Number.
Wyoming—Continued.	
Beulah, Sand Creek	10,000
Willow Pond	1,500
Big Lake, Big Lake	280
Cody, Belknap Creek	12,000
Bob Cat Creek	6,000
Boulder Creek	12,000
Britleher Creek	12,000
Elk Fork Creek	12,000
Fall Creek	12,000
Fish Hawk Creek	12,000
Green Creek	12,000
Jim Creek	12,000
Rock Creek	12,000
Shoshone River, North Fork	12,000
Crystal Springs Lake, Crystal Springs Lake	280
Evenston, Chesney's pond	4,000
Jackson, Crystal Creek	10,000
Lander, Beaver Creek	2,800
Big Wind River	2,100
Bull Lake Creek	2,100
Dinwoodie Creek	2,100
Dunoir Creek	2,100
Horse Creek	2,100
Little Popo Agie River	2,800
Little Wind River	2,100
Lost Creek	2,800
Pine Creek	2,800
Popo Agie River	2,800
Wyoming—Continued.	
Lander, Popo Agie River, North Fork	2,100
Sage Creek	2,100
Spring Creek	2,100
Squaw Creek	2,800
Sweetwater River	2,800
Wind River	2,800
Laramie, Bear Lake	20,000
Lost Lake	20,000
State fish commission	*100,000
Telephone Lake	20,000
Manderson, State fish commission	*113,000
Opal, State fish commission	*227,000
Ranchester, Wolf Creek	9,000
Rock Springs, Half Moon Lake	8,000
Sand Creek, Sand Creek	1,680
Saratoga, Cedar Creek	14,000
Jack Creek	15,000
Lake Creek	5,000
North Platte River	75,000
South Jack Creek	15,000
South Spring Creek	15,000
Spring Creek	15,000
South Redwater Creek, South Redwater Creek	560
Sundance, Miller Creek	2,800
Total[a]	*2,939,820 † 38,500 3,409,190

BLACKSPOTTED TROUT.

Disposition.	Number.
Arizona: Douglas, Turkey Creek (West)	6,000
Colorado:	
Austin, Dirty George Creek	6,000
La Reux Creek	12,000
Surface Creek	10,000
Ward Creek	8,000
Youngs Creek	8,000
Colorado Springs, Cheyenne Creek, North Fork	4,500
Little Fountain Creek	6,000
Crested Butte, Coal Creek	6,000
East River	12,000
Cripple Creek, Fig Pond	2,000
Woods Lake	10,000
De Beque, Big Creek	3,000
Big Creek Lake	2,000
Bull Creek	3,000
Buzzard Creek	3,000
Coon Creek	2,000
Grove Creek	2,000
Hawxhurst Creek	2,000
Kahnah Creek	14,000
Lenox Creek	2,000
Leon Creek	2,000
Mesa Creek	2,000
Mesa Lake	2,000
Park Creek	2,000
Plateau Creek	3,000
Dillon, Beaver Ponds	2,000
Brush Creek	6,000
Lost Lake	4,000
Meadow Creek	4,000
Slate Creek	6,000
Slate Lake	4,000
Straight Creek	4,000
Divide, Loshbaugh's pond	2,000
Edwards, Lake Creek	12,000
Empire, Clear Creek, North Fork	4,500
Fairplay, South Platte River	8,000
Florence, Middle Creek	3,000
South Hardscrabble Creek	9,000
Grant, Geneva Creek	8,000
Colorado—Continued.	
Hillside, Dismore Creek ponds	3,000
Hotchkiss, Clear Fork Creek	6,000
Smith Fork Creek	8,000
Hot Springs, California Creek	4,000
Carnero Creek, Middle Fork	4,000
Carnero Creek, South Fork	6,000
Hodding Creek	4,000
Middle Creek	6,000
Miners Creek	4,000
Saguache Creek	6,000
Sheep Creek	4,000
Idaho Springs, Bear Creek	6,000
Fall Creek	3,000
Leadville, Big Union Creek	2,000
Box Creek	12,000
Emerald Creek	10,000
Empire Creek	2,000
Musgrove Lake	2,000
Malta, Big Evans Creek	3,000
Lake Creek	5,000
Minturn, Gore Creek	8,000
Moffatt, North Crestone Creek	16,000
Rita Alta Creek	6,000
New Castle, Middle Elk Creek	8,000
Pando, Eagle River	14,000
Paonia, East Muddy Creek	14,000
Henderson Creek	6,000
Terror Creek	10,000
West Muddy Creek	8,000
Puzzler, Shadow Creek	1,000
Ridgeway, Cimarron River	10,000
Cow Creek	8,000
Salida, Big Cottonwood Creek	4,500
Sapinero, Pass Creek	8,000
Upper Taylor River	10,000
Victor, Skaguay Lake	8,000
Woodland Park, Carroll Lakes	12,000
Northfield Lake	8,000
Idaho:	
Ashton, Black Pond	7,500
Hauser, Hauser Lake	12,250

[a] Exclusive of 29,750 fingerlings lost in transit.

Total Distribution of Fish and Fish Eggs, by Species, Fiscal Year 1919—Continued.

BLACKSPOTTED TROUT—Continued.

Disposition.	Number.
Michigan: Detroit, Aquarium	*12,000
Montana:	
Alberton, Rancourt's pond	1,750
Belgrade, East Gallatin River	14,000
West Gallatin River	16,000
Belton, Lake McDonald	32,000
Glacier Park, St. Marys River	105,000
Two Medicine River	105,000
Heron, Elk Creek	10,500
Lewistown, War House Lake	20,000
Libby, Fisher River	20,000
Missoula, Bear Creek	8,000
Beaver Creek	6,000
Bitter Root River	8,000
Blanchard Creek	8,000
Butler Creek	6,000
Camas Creek	8,000
Cottonwood Creek	6,000
Deer Creek	4,000
Dick Creek	4,000
Fish Creek	8,000
Gold Creek	6,000
Grant Creek	8,000
Graves Creek	6,000
Hayes Creek	4,000
Johnson Creek	6,000
Kramer Creek	8,000
Marshall Creek	6,000
Miller Creek	8,000
Montour Creek	8,000
O'Keefe Creek	6,000
Pattee Creek	6,000
Raster Creek	6,000
Rattlesnake Creek	8,000
Six Mile Creek	8,000
Twin Creeks	6,000
Warren Creek	4,000
Noxon, Pilgrim Creek	8,750
Piper, McDonald Creek	4,500
Saltese, Big Sunday Creek	7,000
Brimstone Creek	8,750
Dominion Creek	8,750
Packer Creek, West Fork	8,750
Rainy Creek	8,750
Randolph Creek	8,750
Randolph Creek, East Fork	8,750
Randolph Creek, North Fork	7,000
St. Regis River	12,250
St. Regis Slough Ponds	1,750
Silver Creek	8,750
Silver Lake	8,750
Thompson Falls, Prospect Creek	8,750
Thompson River	14,000
Three Forks, Madison River	20,000
Trout Creek, Trout Creek	10,500
Troy, O'Brien Creek	8,000
Warland, Five Mile Creek	10,000
Whitefish, Haskill Creek	10,000
Stillwater River	20,000
Whitepine, Big Beaver Creek	12,250
White Sulphur Springs, Checkerboard Creek	8,000
Eagle Creek	8,000
Eight Mile Creek	6,000
Four Mile Creek	8,000
Little Birch Creek	8,000
Willow Creek	6,000
Woods Gulch Creek	6,000
Nebraska: Andrews, White River	7,500
New Mexico:	
Albuquerque, Jemez River	9,600
Buckman, Alamo Canyon Creek	6,000
Chama, Canones Creek	14,000
Ensenada River	8,000
Lower Chama River	8,000
Tierra Amarilla Creek	8,000
Cimarron, Ponil Creek	6,000
Shuree Creek	7,200
New Mexico—Continued.	
East Las Vegas, Gallinas River	9,600
Rio de la Casa	2,400
Trout Springs Creek	1,200
Embudo, Agua Piedra River	8,000
Angustora River	8,000
Little Rio Grande	6,000
Rio Junta	6,000
Rio Pueblo	14,000
Rio Santa Barbara	6,000
Glorietta, Bradleys Pond	7,200
Jacks Creek	4,800
Pecos River	21,600
Ortiz, Los Pinos River	8,000
San Antonio River	8,000
Raton, City Lake	4,800
Sugarite Creek	2,400
Santa Fe, Nambe River	8,000
Rio Capulin	8,000
Rio Medio	8,000
Santa Fe Creek	10,000
Tesuque Creek	8,000
Silver City, Dry Creek	6,000
Taos, Latir Creek	6,000
Lucero Creek	6,000
Pot Creek	6,000
Rio Hondo	6,000
Taos Creek	6,000
Ute Park, American Creek	2,400
Bitter Creek	4,800
Cimarron River	3,600
Clear Creek	3,600
Eagle Nest Creek	7,200
East Cieneguilla Creek	1,200
Goose Creek	2,400
Hewitt Creek	1,200
Nine Mile Creek	3,600
Red River	3,600
Tolby Creek	2,400
West Agua Fria Creek	2,400
Wooten, Fresnal Canon Creek, North Fork	2,400
Oregon:	
Bonneville, State fish commission	*121,000
Forest Grove, Dairy Creek	6,000
Gales Creek	6,000
Patton Creek	6,000
Scoggins Creek	6,000
La Grande, Grand Ronde River, South Fork	6,000
Oregon City, Molalla River and tributaries	10,000
Trail, Rogue River	37,700
South Dakota:	
Big Stone City, Big Stone Lake	15,000
Englewood, Hanna Creek	10,000
Hanna Creek, East Fork	8,000
Landis Creek	10,000
Spearfish Creek, South Branch	8,000
Ward Creek	8,000
Hill City, Newtons Fork Creek	6,000
Palmer Gulch Creek	6,000
Patterson Gulch Creek	6,000
Spring Creek	12,000
Sunday Gulch Creek	6,000
Hot Springs, Beaver Creek	8,000
Rapid City, Deer Creek	6,000
Lockhart Pond	4,500
Murphy Pond	8,000
Rapid Creek	25,000
Rounds Pond	6,000
Schambers Pond	6,000
Sickler Pond	4,500
Spring Creek	20,000
Rochford, Gimlet Creek	6,000
South Box Elder Creek, Branch of	6,000
Spearfish, Boneta Spring Branch	6,000
Little Sand Creek	10,000

Total Distribution of Fish and Fish Eggs, by Species, Fiscal Year 1919—Continued.

BLACKSPOTTED TROUT—Continued.

Disposition.	Number.
South Dakota—Continued.	
Spearfish, Sand Creek	,000
Silver Spring Branch	6,000
Tilford, Morris Creek	4,500
Utah:	
Springville, Spring Creek	213,550
Strawberry Reservoir, Strawberry Reservoir	40,000
Washington:	
English, Cranberry Lake	10,000
Lake Goodwin	14,000
verett, Fleming Lake	12,000
Lake Armstrong	10,000
Lake Isabel	14,000
Mud Lake	6,000
Montesano, Cook Creek	4,000
North Bend, Pratt Lake	6,000
Northport, Deep Creek	14,000
Deep Creek Lake	18,000
Pepon Lake	14,000
Satsop, Big Creek	4,000
Stevenson, Boles Creek	2,000
Duncan Creek	3,000
Little White Salmon River	6,000
Rock Creek	10,000
Washougal River	6,000
Washougal River, North Fork	3,000
Wind River	6,000
Woodard Creek	4,000
Tacoma, Carney Lake	10,000
Crescent Lake	6,000
Lake Lapps	14,000
South Prairie Creek	12,000
Voight Creek	12,000
Vancouver, Big Creek	10,000
Cedar Creek	10,000
Wyoming:	
Clearmont, Clear Creek	9,000
Trigger Lake	3,000
Wyoming—Continued.	
Cody, Crow Creek	7,500
Hard Pan Creek	6,000
Jordan Creek	6,000
Libby Creek	6,000
Moss Creek	6,000
Post Creek	6,000
Sage Creek	10,500
Shoshone Lake	15,000
Sweetwater Creek	7,500
Whit Creek	6,000
Encampment, Encampment Creek	30,000
Encampment Creek, North Fork	20,000
Little Snake River and Branches	30,000
Miner Creek and Branches	20,000
Soldier Creek	20,000
Laramie, Lewis Lake	30,000
Lookout Lake	35,000
Sand Lake	35,000
Powell, Ishawooa Creek	10,500
Marquette Creek	7,500
Murray Creek	4,500
Saratoga, Cedar Creek	24,000
Bow Creek	20,000
Jacks Creek	20,000
South Spring Creek	5,000
Sundance, Miller Creek	4,000
Thumb, Clear Creek	† 35,000
Columbine Creek	† 30,000
Cub Creek	† 45,000
Hatchery Creek	† 90,000
Wamsutter, Battle Creek	20,000
Big Sandstone Creek	20,000
Little Sandstone Creek	15,000
Little Snake River	25,000
Total	* 133,000 † 200,000 2,875,100

LOCH LEVEN TROUT.

Disposition.	Number.
Colorado: Parkdale, Arkansas River	60,000
South Dakota:	
Rapid City, Ash Creek	4,000
Barker Pond	1,000
Burglar Pond	1,000
Canyon Pond	1,000
South Dakota—Continued.	
Rapid City, June Pond	1,000
Lomond Pond	1,000
Plum Creek	4,000
Total	73,000

LAKE TROUT.

Disposition.	Number.
Colorado: Leadville, Twin Lakes	20,000
Massachusetts: Woronoco, Big Pond	1,200
Michigan:	
Alpena, Lake Huron	† 200,000
Beaver Harbor, Lake Michigan	† 1,136,640
Beaver Head Reef, Lake Michigan	† 2,275,840
Belle Isle, Aquarium	*18,000
Big Rock Reef, Lake Michigan	† 1,144,320
Charlevoix, Lake Michigan	† 4,577,280
Pine Lake	† 200,000
State fish commission	*1,000,000
Cheboygan, Hammond Bay	† 200,000
Dahlis Shoal, Lake Michigan	† 1,144,320
Escanaba, Lake Michigan	† 500,000
Fishermens Home, Lake Superior	† 600,000
Fishermens Island, Lake Superior	† 400,000
Fishermens Reef, Lake Michigan	† 2,288,640
Fish Island, Lake Superior	† 100,000
Frankfort, Lake Michigan	† 100,000
Harbor Beach, Lake Huron	† 200,000
Houghton, Lake Superior	† 625,000
Iron River, Pickerel Lake	10,000
Trout Lake	15,000
Michigan—Continued.	
Isle Royale, Lake Superior	† 272,500
Long Point, Lake Superior	† 800,000
Marquette, Lake Superior	† 625,000
Munising, Lake Superior	† 625,000
Nine Mile Point, Lake Michigan	† 2,288,640
Norwood Reef, Lake Michigan	† 1,144,320
Rock Harbor, Lake Superior	† 600,000
St. Ignace, Lake Huron	† 100,000
St. Joseph, Lake Michigan	† 200,000
Tobens Harbor, Lake Superior	† 600,000
Washington Harbor, Lake Superior	† 200,000 262,000
Wrights Island, Lake Superior	† 600,000
Minnesota:	
Beaver Bay, Lake Superior	† 400,000
Bovey, Watson Lake	6,000
Chicago Bay, Lake Superior	† 300,000
Deer River, Deer River	20,000
Duluth, Lake Superior	26,500
French River, Lake Superior	† 400,000 80,000
Grand Maraias, Lake Superior	† 600,000

Total Distribution of Fish and Fish Eggs, by Species, Fiscal Year 1919—Continued.

LAKE TROUT—Continued.

Disposition.	Number.
Minnesota—Continued.	
Grand Portage, Lake Superior	†600,000
Knife River, Lake Superior	†480,000
	100,000
St. Paul, State fish commission	*250,000
Spring Brook, Carver Lake	10,000
Sucker River, Lake Superior	†400,000
	80,000
Susie Island, Lake Superior	†200,000
New Hampshire:	
Lake Tarleton, Lake Tarleton	710
Newport, Long Pond	3,000
New York:	
Albany, State fish commission	*1,800,000
Fuller Bay, Lake Ontario	†182,250
Gabriels, Lake Meacham	†19,500
Grenadier Island, Lake Ontario	†177,725
Lake Clear, Lake Placid	†14,500
Port Henry, Clear Pond	†24,000
Port Jervis, Bauer Lake	†15,000
Watkins, Seneca Lake	†35,000
South Dakota: Fruitdale, Reclamation Reservoir	27,975
Vermont:	
Barton, Stone Pond	660
Canaan, Big Averill Lake	1,000
Vermont—Continued.	
Newport, Echo Pond	660
Seymore Lake	1,406
Orleans, Long Pond	1,410
Willoughby Lake	660
Wisconsin:	
Couderay, Devils Lake	10,000
Spring Lake	15,000
Windfall Lake	20,000
Donaldson, Black Oak Lake	20,000
Drummond, Lake of the Woods	3,000
Laona, Rat Lake	15,000
Port Wing, Lake Superior	†600,000
Wyoming:	
Lander, Brooks Lake	2,000
Bull Lake Creek	2,000
Crowheart Lake	2,000
Fry Lake	2,000
Lake of the Woods	2,000
Lewis Lake	2,000
Silas Lake	2,000
Total [a]	*3,068,000
	†28,495,475
	765,180

BROOK TROUT.

Disposition.	Number.
Alabama: Anniston, Jordan Brook	4,500
Alaska: Juneau, applicant	*50,000
Colorado:	
Arkansas Junction, Turquoise Lake	113,500
Bilk Siding, Bilk Creek	10,000
Boulder, Four Mile Creek	45,000
Jim Creek	45,000
Left Hand Creek	30,000
Canon City, Beaver Creek	30,000
East Beaver Creek	20,000
Sells Lake	6,000
Colorado Springs, Erie Lake	5,000
Frantz Lake	60,000
Hay Creek	9,000
Mesa Lake	5,000
Monument Creek Lake	9,000
Queens Canyon Creek	20,000
Crested Butte, Slate River	10,000
Cripple Creek, Rule Creek Lake	4,000
Denver, Bear Creek	69,000
Clear Creek, North Fork	20,000
Cub Creek	20,000
Dillon, Cataract Creek	12,000
Cataract Lake	69,000
Slate Creek	15,000
Divide, Copland Creek	4,000
Dolores, Stoner Creek	10,000
West Dolores River	10,000
Eldora, Lake Eldora	6,000
Fairplay, High Creek	12,000
Fort Collins, Cache La Poudre River	60,000
Lone Pine Creek	15,000
Glenwood Springs, Grizzly Creek	16,000
Granby, Blayney Slough Pond	10,000
Buffalo Creek	5,000
Spring Creek	5,000
Stillwater Creek	10,000
Supply Creek	7,500
Willow Creek	12,500
Hillside, Balman Lake	25,000
Leadville, Arkansas River	30,000
Half Moon Creek	12,500
Lake Creek	25,000
Lake Creek, South Fork	12,000
Tennessee Creek	24,000
Timberline Lake	8,000
Colorado—Continued.	
Lime Siding, Deep Creek	5,000
Loveland, Big Thompson River	60,000
Lyons, North St. Vrain Creek	18,000
South St. Vrain Creek	16,000
Maddox, South Platte River	40,000
Malta, Empire Creek	8,000
Mancos, Echo Creek	5,000
Monte Vista, Alamosa River	10,000
Conejos River	10,000
Rock Creek, South Fork	10,000
Osier, Los Pinos River	15,000
Pagosa Springs, San Juan River, West Fork	20,000
Taylor Canon Creek	10,000
Pando, Eagle River	50,000
Placerville, Beaver Creek	20,000
Naturita Creek	20,000
Saltado Creek	20,000
Puzzler, Yuki Lake	22,000
Radium, Sheephorn Creek	10,000
Salida, Willow Dale Ponds	24,000
Silverton, South Mineral Creek	10,000
South Fork, Bear Creek	10,000
Dyers Creek	10,000
Goose Creek	15,000
Rio Grande, South Fork	10,000
Steamboat Springs, Cody Lake	2,500
Gold Creek Lake	10,000
Tabernash, Cabin Creek	7,500
Crooked Creek	10,000
Pole Creek	7,500
Thomasville, Englebrecht Lakes	30,000
Timber Spur, West Dolores River	12,500
Trinidad, Purgatory River	40,000
Purgatory River, Middle Fork	40,000
Troublesome, Rabbit Ear Creek	5,000
Troublesome Creek, East Fork	10,000
Troublesome Creek, West Fork	10,000
Vanadium, Big Bear Creek	10,000
Victor, Bison Creek	8,000
Skaguay Lake	12,000
Woods Lake	6,000
Yampa, Blue Lake	5,000
Chatfield Lake	10,000

[a] Exclusive of 2,204 fingerlings lost in transit.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

BROOK TROUT—Continued.

Disposition.	Number.
Colorado—Continued.	
Yampa, Crosho Lake	5,000
Heart Lake	10,000
Hunt Creek	7,500
Lily Lake	7,500
Middle Hunt Creek	7,500
Moody Creek	5,000
North Hunt Creek	10,000
Rainbow Lake	10,000
Round Lake	5,000
Simon's pond	2,500
South Hunt Creek	10,000
Stillwater Lake	10,000
Watson Creek	5,000
Connecticut:	
Cheshire, Ten Mile River	6,000
East Haddam, Early Brook	3,500
Martin Brook	500
Selden Brook	3,000
Forestville, Cold Brook	1,600
Hartford, Abbot Pond	500
Broad Brook	4,000
Salmon Brook	5,000
Silver Brook	4,000
Westbrook Creek	500
Long Hill, Willow Brook	4,000
Meriden, Albert Bacon Brook	3,000
Honey Pot Brook	3,000
Meeting House Brook	2,000
Misery Brook	4,000
Parker Brook	1,200
Pipesdale Brook	2,000
Sodam Brook	1,200
Spruce Glen Brook	1,200
Westfield Falls Brook	1,200
Willow Brook	1,500
Norwalk, Wilson Brook	2,400
Stepney, Pepper Street Brook	3,000
Washington, Bee Brook	3,000
Chapel Brook	1,000
Mallory Brook	8,000
Sawmill Brook	2,000
Walker Brook	5,000
Wood Brook	6,000
Waterbury, DeBishop Pond	500
Mad River	500
Wauregan, Blackwell Brook	5,000
Georgia:	
Blue Ridge, Rock Creek	9,000
Nacoochee, Bell Branch	5,400
Simmons Branch	5,400
Idaho:	
Fort Hall, Clear Creek	1,050
Ross Fork Creek	3,500
Spring Creek	1,400
Franklin, Bear River	2,000
Payette, Shamberger's pond	1,500
Pocatello, Marsh Creek	8,500
Pebble Creek	1,250
Preston, Bear Lake	2,800
Bear River	4,050
Indiana:	
Michigan City, Palmer Brook	4,500
Schurz's pond	3,000
Wolff Creek	3,000
Iowa:	
Calmar, Glenwood Creek	2,000
Manchester, Spring Branch	390
Kentucky:	
Bowling Green, Jennings Creek	75
South Union, Clear Creek	75
Maine:	
Belfast, Kimball Brook	† 4,000
Bigelow, Spring Lake	11,000
Bingham, Bean Pond	† 5,700
Pleasant Pond	† 8,550
Rowe Pond	† 8,550
Maine—Continued.	
Boundary, Boundary Pond	† 9,000
Clear Pond	† 9,000
Mud Pond	† 9,000
Unknown Pond	† 9,000
Brownfield, Little Saco River	† 12,000
Shepards River	† 12,000
Bryant Pond, Christopher Lake	† 9,000
Byron, Garland Pond	† 9,000
Corinna, Alder Brook	† 6,000
Cornish, Berry Brook	† 6,000
Mine Pond	† 9,000
Stanley Ponds	† 9,000
Trafton Pond	† 6,000
Dennysville, Cathance Brook	† 12,000
Dennys River	† 15,000
Wilson Brook	† 9,000
Dexter, Half Moon Pond	† 6,000
Jimmie Brook	† 3,000
Pitts Brook	† 3,000
Eagle Lake, Eagle Lake	12,000
East Orland, Craig Pond	† 75,000
Gully Brook	† 10,000
Harts Pond	† 12,500
Patten Pond	6,200
Ellsworth, Beech Hill Lake	† 24,000
Branch Pond	† 100,000
Patten Pond	† 75,000
Franklin, Donnells Pond	† 12,000
Fryeburg, Buck Brook	† 6,000
Clays Brook	† 6,000
Cold River	† 12,000
Little Cold River	† 9,000
Little Saco River	† 6,000
Wards Pond and Brooks	† 3,000
Gilead, Wild River and tributaries	73,800
Grand Lake Stream, Grand Lake	† 48,480
Green Lake, Mann Brook	† 50,000
Greenville Junction, Wilson Pond	† 18,000
Harmony, Grant Brook	† 6,000
Holeb, Fish Pond	† 6,000
Gulf Brook	† 6,000
Holeb Lake	† 12,000
Moose River	† 12,000
Turner Pond	† 6,000
Unknown Pond	† 6,000
Island Falls, Mattawaumkeag Lake	†8,700
Jackman, Attean Lake	†15,000
Bog Pond	†6,000
Clearwater Pond	†6,000
Cold Stream Pond	†9,000
Crocker Pond	†9,000
Enchanted Lake	†15,000
Gander Brook	†9,000
Hatchery Brook	†6,000
Horseshoe Pond	†9,000
Lake Parlin	†9,000
Little Bid Wood Lake	†9,000
Long Pond	†6,000
Moose River	†9,000
Sandy Brook	†9,000
Slackers Pond	†6,000
Kennebago, Kennebago Lake	†12,000
Kineo, Carry Brook	†2,000
Moose River	†8,000
Socatean Creek	†10,000
Lincoln Mills, Alder Brook	†3,000
Livermore Falls, Tilton Pond	†6,000
Machias, Fulton Lake	†9,000
Mattawaumkeag, Wyman Brook	†9,000
Monmouth, Cochnewagan Lake	†9,000
Moodys Crossing, Weymouth Pond	†9,000
North Anson, Embden Pond	†11,400
North Belgrade, Messalonskee Lake	†15,000
Oldtown, Birch Creek	†15,000
Titcomb Pond	†12,500
Otis, Green Lake	†193,200

Total Distribution of Fish and Fish Eggs, by Species, Fiscal Year 1919—Continued.

BROOK TROUT—Continued.

Disposition.	Number.
Maine—Continued.	
Pembroke, Boyden Lake	†15,000
Portage, Portage Lake	†10,000
Portland, Beaver Brook	†6,000
Forest Lake	†9,000
Little River	†12,000
Red Brook	†6,000
Presque Isle, Presque Isle River	†14,500
Squapan Lake	†11,600
Princeton, Huntley Brook	8,000
Saco, Boothby Brook	†3,000
Burham Brook	†3,000
Carter Brook	†3,000
Deep Brook	†9,000
Foos Brook	†3,000
Foxwell Brook	†9,000
Freshwater Brook	†9,000
Goose Fare Brook	†9,000
Harmon Brook	†6,000
Holmes Brook	†3,000
Lilley Brook	†3,000
Meade Brook	†9,000
Ricker Brook	†3,000
Sebago Lake, North Branch	†6,000
Sherman, Davis Pond	4,000
Skinner, Barrett Pond	†6,000
Bog Brook	†6,000
Indian Pond	†9,000
Lowell Pond	†6,000
Twin Island Pond	†9,000
South Orrington, Douglas Pond	†15,000
South Paris, Abbot Pond	†6,000
Concord River	†9,000
Shagg Pond	†9,000
Spear Creek	†9,000
Twenty Mile River	†15,000
Washburn Pond	†3,000
Unity, Unity Pond	†6,000
Walker Siding, Squa Pan Creek	6,000
Whitneyville, Arna Meadow Brook	†6,000
Winthrop, Lake Maranacook	†12,000
Woodland, Anderson Brook	6,000
Maryland:	
Academy Junction, Towsers Branch	4,000
Anne Arundel, Stoney Run	3,000
Carrollton, Greens Run	500
Reeds Run	500
Cumberland, Dickerson Run	5,000
Everett Creek	2,200
Deer Park, Watson Lake	2,000
Frostburg, Bear Creek	6,000
Big Laurel Run	4,000
Puzzler Run	5,000
School House Run	2,000
Spiker Run	2,000
Two Mile Run	1,000
Hampstead, Indian Run	1,500
Kitzmiller, Lost Land Run, East Prong	4,000
Lost Land Run, West Prong	2,000
Short Run	1,000
Wolf Den Run	2,000
Lonaconing, Mud Lick Creek	2,000
Mullikin, Eglinton Run	2,000
Oakland, Cherry Creek	4,000
Muddy Run	8,000
Ruxton, Callendar House Pond	500
Takoma Park, Sligo Creek	300
Massachusetts:	
Athol, Thrower Brook	10,000
Barre, Gaston's pond	12,500
Clinton, Berlin Brook	15,000
Clamshell Pond Brook	8,000
Collins Brook	11,000
Sheehan Brook	8,000
Dalton, Cady Brook	400
Windsor River	1,000
Great Barrington, Alford Brook	3,400
Dalzell Brook	3,000
Massachusetts—Continued.	
Great Barrington, Egremont Brook	400
Goodale Brook	400
Green River	13,800
Harmon Brook	11,400
Konkapot River	24,400
Lee Brook	400
Muddy Brook	3,400
Roaring Brook	400
Seekonk River	8,000
Spring Brook	1,000
Swann Brook	3,000
Umpacheenee Brook	3,000
Williamsville River	5,800
Hinsdale, Fox Brook	300
Washington Pond Brook	400
Holyoke, Paddy Hill Brook	600
Spruce Corner Brook	800
Hoosac Tunnel, Cold River	4,000
Paddleford Brook	2,800
Lenox, Belden Brook	1,000
Yokum Brook	6,000
Millbury, Cronin Brook	600
Monterey, Meadow Brook	1,250
Mountain Brook	1,250
Ransome Brook	8,000
North Dana, Silver Brook	2,400
Northampton, Walker Pond	5,000
Orange, Stevens Pond	10,600
Whitney Pond	7,500
Palmer, Burleigh Brook	4,800
Pittsfield, Clark Brook	2,000
Jacoby Brook	4,000
Sackett Brook	8,500
School House Brook	5,000
Secum Brook	8,000
Shaker Brook	2,000
Town Brook	9,500
Yokum Brook	4,000
Shelburne Falls, Bare River	6,000
South Lee, Bear Mountain Brook, East Branch	5,000
Bear Mountain Brook, West Branch	5,000
Springfield, Allen Pond	400
Grassy Meadow Brook	3,000
Stockbridge, Konkapot River	1,200
Tyngsboro, Carney's pond	2,000
Westfield, Big Powder Mill Brook	6,000
Blandford Brook	4,800
Loomis Street Brook	7,200
Manhan River	9,600
Potash Brook	7,200
Sandy Mill Brook	4,800
Michigan:	
Alpena, Beaver River	7,500
Comstock Creek	3,000
Little Wolf Creek	4,500
Baldwin, Baldwin Creek	9,375
Baraga, Grandville Creek	†1,000
Plumbago Creek	†2,000
Beulah, Betsy River	2,500
Branch, Weldon Creek	9,375
Calumet, Agate River	†4,000
Beaver Creek	†3,000
Beaver Dam Pond	†1,000
Buffalo River	†3,000
Eagle River	†4,000
Garden City Pond	†1,000
Garden City River	†3,000
Gratiot River	†5,000
Hills Creek	†9,000
Horseshoe Creek	†2,000
Horseshoe Lake	†4,000
Little Gratiot River	†5,000
Medora River	†2,000
Meadow Dam Pond	†1,500
Mineral River	†3,000
Montreal River	†14,000

Total Distribution of Fish and Fish Eggs, by Species, Fiscal Year 1919—Continued.

BROOK TROUT—Continued.

Disposition.	Number.
Michigan—Continued.	
Calumet, Mosquito Creek	† 2,000
North American River	† 5,000
Old Cliff Meadow Pond	† 1,000
One Mile Farm Creek	† 1,500
Seward Creek	† 3,000
Tobacco River	† 5,000
White Birch Creek	† 3,000
Charlevoix, Horton Creek	† 15,000
Inwood Creek	† 16,000
Iron Ore Creek	2,000
McGeagh Creek	† 20,000
Monroe Creek	† 10,000
Stover Creek	† 20,000
Cheboygan, Laperal River	† 21,000
Clare, Chard Creek	† 7,500
Five Lake Creek	† 6,000
Halstead Creek	† 7,500
Lowry Creek	† 5,000
McEwen Creek	† 6,000
Morrison Creek	† 5,000
Parrish Creek	† 6,000
Sanford Creek	† 6,000
Crystal Falls, Briar Hill Creek	2,000
Chicagoan Creek	2,500
Clark Creek	2,000
Peterson Creek	1,500
Connors, Gilchrist Creek	20,000
Dryden, Lees Pond	5,000
Eagle Mills, Morgan Creek	† 4,000
East Tawas, Indian Creek	† 10,000
Loud Creek	† 10,000
Silver Creek	33,000
Tawas Creek	4,500
Vaughn Creek	† 10,000
Emison, Net River	1,500
Frankfort, Betsy River	2,500
Gaylord, Au Sable River	15,000
Hale, Smith Creek	† 10,000
Highland, Rock Creek	10,000
Spring Creek	10,000
Ishpeming, Barnhart Creek	† 4,000
Dead River	† 1,000
Escanaba River and tributaries	† 18,000
Green Creek	† 4,000
Spruce River	† 2,000
Jackson, Crouches Creek	4,500
Lake Linden, Spring Creek	† 1,500
Lake Mine, Fire Steel Creek	† 6,000
Little Lake, Connors Creek	† 2,000
Marietta, Slagel River	5,000
Mastodon, Mastodon Creek	1,000
Onaway, Rainy Lake	9,000
Tomahawk Creek	6,000
Ontonagon, Cranberry River	† 3,000
Cunningham Creek	† 2,000
Deer Creek	† 4,000
Oscoda, Pine River	† 10,000
Park Siding, Reservoir Creek	1,000
Parma, Raymond Creek	3,000
Pellston, Maple River	15,000
Petosky, Heber Creek	† 10,000
Raco, Sullivan Creek	† 8,000
Rockland, Rockland Creek	† 3,000
Roscommon, Au Sable River, South Branch	† 2,000
Sidnaw, Sidnaw Creek	3,000
Trimountain, Cushman Creek	† 4,000
Wingleton, Baunan Creek	3,750
Sweetwater Creek	15,000
Yuma, Slagle Creek	12,000
Minnesota:	
Alborn, Americana Pond	† 1,000
Brownsville, Driscoll's pond	500
Caledonia, Irish Creek	1,000
Clearbrook, Clearbrook Creek	† 5,000
Ruffy Creek	† 3,000
Dover, Crown Creek	500
Drake Creek	500
Minnesota—Continued.	
Dover, Logan Branch	500
Middle Branch	1,000
South Branch	1,500
Trout Creek	500
Duluth, Amity Creek, West Branch	† 2,000
French River	† 1,500
Gooseberry River	† 2,500
Knife River	† 2,500
Little Cloquet River	† 2,500
Pine River	† 1,500
Shadow Lake	† 3,000
Stewart River	† 2,000
Sucker River	† 2,500
Ely, Burntside River	† 2,000
Lonstorf Creek	† 2,000
Section Thirty Creek	† 1,000
Mazeppa, Trout Creek	400
Preston, Camp Creek	1,000
St. Charles, Campbell Creek	500
Demouth Creek	500
Drakes Creek	500
Ferguson Creek	500
Hemmingway Creek	500
Holms Creek	500
Holts Creek	500
Logan Branch	500
Middle Branch	500
Nichols Creek	500
North Branch	500
Pettie Creek	500
Quincy Creek	500
South Branch	500
Trout Creek	500
Troy Creek	500
Whitewater River	500
Spring Grove, Bee Creek	1,000
Riceford Creek	1,000
Upper Bear Creek	1,000
Twin Valley, Marsh Creek	† 3,000
Two Harbors, Crow Creek	† 2,000
Encampment River	† 2,000
Knife River and branches	† 9,000
Little Stewart River	† 1,500
Silver Creek	† 2,500
Splitrock Creek	† 3,000
Splitrock Creek, North Branch	† 2,000
Stewart River	† 2,500
Stone Creek	† 1,500
Montana:	
Ballantine, Arrow Creek	600
Belgrade, Thompson Creek	1,750
Belton, Conlons Bay	† 90,000
Kelleys Bay	† 10,000
Big Timber, Bologne Creek	2,400
Cayuse Creek	4,800
East Boulder River	12,000
Lower Deer Creek	9,000
Mussellshell River, American Fork	7,200
Otter Creek	7,200
Swamp Creek	4,800
West Boulder Creek	9,000
Billings, Sage Creek	12,000
Bozeman, Angell Creek	9,600
Baker Creek	10,000
Bamber Creek	2,000
Benhart Creek	900
Bostwick Creek	300
Cache Creek	600
Camp Creek	26,500
Cherry Creek	600
Cockerill Creek	1,000
Cottonwood Creek	4,500
Cowan Creek	1,800
Curtiss Creek	11,500
Dry Creek	8,250
Fish Creek	4,500
Gallatin River, Middle Fork	300
Heeb Creek	4,500

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

BROOK TROUT—Continued.

Disposition.	Number.
Montana—Continued.	
Bozeman, Jaekel Creek	3,000
Kennedy Creek	2,700
Lansing Creek	5,250
Martin Creek	2,000
Meadow Creek	600
Middle Creek	1,500
O'Dell Creek	600
Pass Creek	6,300
Reese Creek	3,450
Ross Creek	6,300
Sales Creek	1,500
Smith Creek	3,000
South Dry Creek	600
Spring Hill Creek	9,000
Story Creek	11,000
Stuckey Creek	5,250
Sun River, North Fork	12,500
Thompson Creek	6,700
Tice Creek	3,000
Wild Rose Pond	1,500
Brisbin, Brisbin Creek	800
Chestnut, Goose Creek	1,600
Columbus, Stillwater River	12,000
Darby, Bitter Root Creek	350
Robinson's pond	1,050
Dell, Big Sheep Pond	4,200
Emigrant, Pine Creek	3,200
Forest Grove, Bear Creek	1,750
Tyler Creek	2,800
Fort Benton, Shonkin Creek	12,000
Gardiner, Upper Rock Creek	2,800
Gilman, Sun River and tributaries	33,000
Glacier Park, park waters	† 250,000
Harlowton, Big Elk Creek	21,600
Boyd Creek	350
Bozeman Fork Creek	700
Little Spring Creek	14,400
Warm Spring Creek	700
Homestake, Homestake Reservoir	1,200
Lame Deer, Lame Deer Creek	22,500
Muddy Creek	7,500
Lennep, Allabaugh Creek	10,500
Bozeman Fork Creek	5,250
Comb Creek	3,500
Coyote Creek	3,500
Musselshell River	8,750
Warm Spring Creek	3,500
Lewistown, Casino Creek	13,500
Sage Creek	2,450
Libby, Granite Lake	1,400
Howard Lake	1,400
Jackson Creek	1,400
Rainy Creek	1,050
Livingston, Blood Lake	300
Elbow Creek	450
Fleshman Creek	600
Mortimer Creek	300
Strickland Creek	450
Summerland Creek	1,200
Yellowstone River	1,500
Lodge Grass, Lodge Grass Creek	12,000
Rotten Grass Creek	6,000
Martinsdale, Richmond Creek	2,450
Missoula, Browns Lake	3,200
Dusault Creek	700
Kleinschmidt Lake	3,200
Lo Lo Creek	1,050
Opseta Lake	3,200
Norris, Madison Lake and tributaries	30,000
Piper, McDonald Creek	16,500
Red Lodge, Rock Creek and branches	18,000
Townsend, Dry Creek	1,200
Greyson Creek	1,200
Ray Creek	1,200
Two Medicine Lake, Two Medicine Lake	8,100
Whitefish, Lazy Creek	1,750
Montana—Continued.	
Whitefish, Swift Creek	1,750
Whitefish Lake	1,750
Winston, Vermont and Beaver Creeks	30,000
Yellowstone, Cougar Creek	2,800
Gneiss Creek	2,100
Nebraska:	
Chadron, Dead Horse Creek	2,400
Gordon, Antelope Creek	5,000
Larabee Creek	5,000
Snake Creek	10,000
Spring Creek	5,000
White Clay Creek	6,000
Wounded Knee Creek	6,000
New Hampshire:	
Baileys, Grandview Brook	† 1,000
Ingerson Brook	† 1,000
Mason Brook	† 2,000
Moulton Brook	† 1,000
Palmer Brook	† 1,000
Parker Brook	† 1,000
Plaisted Brook	† 1,000
Priscilla Brook	† 2,000
Roberts Brook	† 1,000
Bartlett, Bartlett Brook	† 7,500
Louisville Brook	† 17,500
Bethlehem Junction, Beaver Brook	† 25,000
Gale River	† 10,000
Golf Link Brook	† 25,000
Little River brooks	† 20,000
State Road Brook	† 5,000
Two Horse Brook	† 10,000
Bradford, Massasecum Lake	8,000
Bristol, Brayley Brook	7,500
Cass Mill Brook	5,250
Cockermouthy River	3,750
Danforth Brook	2,250
Dickerman Brook	4,000
Dick Brown Brook	3,000
Fowler River	3,750
George Brook	2,250
Kimball Hill Brook	4,500
Noyes Brook	5,250
Patton Brook	4,500
Rowell Brook	5,250
Smith River	4,500
Taylor Brook	3,000
Ten Mile Brook	4,500
Welton Brook	2,250
Canaan, Bicknell Brook	4,000
Burnt Hill Brook	6,000
Merrill Brook	3,000
Rogers Brook	3,000
Story Brook	2,000
Wendell Brook	2,000
Wright Brook	6,000
Charlestown, Benware Brook	3,000
Great Brook	6,000
Reservoir Brook	5,000
Cherry Mountain, Cherry Mountain Brook	† 20,000
Israel River	† 20,000
Christine, Lake Christine	† 47,200 8,389
Concord, Bog Meeting House Brook	7,995
Canterbury Brook	7,995
Dolloff and Stumpfield Brooks	7,995
Crawfords, Saco Pond	† 1,000
Saco River	† 9,000
East Kingston, Winkley Brook	3,000
Enfield, Cole Pond	5,000
Hanover Brook	4,000
Lovejoy Brook	3,000
Wells Brook	4,000
Glen, Back Brook	† 1,500
Bog Brook	† 20,000
Elkins's pond	† 3,000
Fernald Farm Brook	† 5,000
Goodrich Brook	† 1,500

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

BROOK TROUT—Continued.

Disposition.	Number.	Disposition.	Number.
New Hampshire—Continued.		New Hampshire—Continued.	
Glen, Rocky Branch	† 3,000	Newport, Blood Brook	4,000
Gorham, Barnes Brook	† 3,000	Cutts Brook	4,000
Barrett Brook	† 3,000	Shedd Brook	2,000
Bear Spring Brook	† 2,000	Walker Brook	2,000
Clay Brook	† 2,000	North Conway, Cedar Brook	† 1,000
Glen Cottage Brook	† 1,000	Kearsage Brook	† 3,000
Glen House Brook	† 1,000	Moat Brook	† 3,500
Jenny Lind Brook	† 2,000	North Woodstock, Ammoosuc River	70,308
Josh Billings Brook	† 1,000	Eastman Brook	600
Lead Mine Brook	† 5,000	Jackman Branch	600
Madison Brook	† 3,000	Johnson Brook	12,840
Moose Brook	† 4,000	Lost River	600
Stony Brook	† 2,000	Pemigewassett River, Middle Branch	600
Greenville, Furnace Brook	4,000	Perry, Christine Lake	1,000
Hill, Bartlett Brook	2,000	Pittsburg, Connecticut Pond	† 5,000
Bennett Brook	2,000	Coon Brook	† 8,000
Colby Brook	2,000	East Inlet Brook	† 12,000
Favor Brook	3,000	Perry Brook	† 15,000
Flounder Brook	4,000	Second Connecticut Lake	† 5,000
Gile Meadow Brook	3,000	Plymouth, Yeaton Brook	900
Knox Brook	2,000	Potter Place, Cole Pond	7,000
Mountain Brook	5,000	Towwow River, Hume Brook	2,000
Intervale, Intervale Brook	† 7,500	Towle Brook	2,400
Lebanon, Bliss Brook	3,000	South Brookline, Rockwood's pond	3,000
Great Brook	6,000	Whitefield, Carroll Brook	† 4,000
Hardy Brook	3,000	Wilton, Blood Brook	6,000
Hibbard Brook	3,000	Hodgdon Brook	4,000
Rix Brook	2,000	Woodsville Wild Ammonoosuc River	900
Stony Brook	4,000	Woodstock, Eastman Branch	600
Londonderry, Solvent Spring Pond	500	New Jersey:	
Lyndeboro, Woodward Brook	2,000	Bernardsville, Hill Brook	1,000
Manchester, Baker Brook	3,000	Clementon, Cold Creek	1,500
Barnard Brook	1,000	Greenloch, Big Lebanon Creek	1,000
Bear Brook	7,995	Oak Ridge, Stony Brook Lake	1,500
Bowman Brook	7,000	Oxford Furnace, Pequest River	1,500
Cohas Brook	8,000	Ridgewood, Belmar Spring Pond	500
Gulf Brook	7,995	Whippany, Badgley Brook	500
Hodgdon Brook	5,000	Woodbury, Richey Run	1,000
Little Cohas Brook	7,995	New Mexico:	
Massabesic Lake	8,000	Carizoza, Rio Bonito, South Fork	5,000
Mill Brook	3,000	Cimarron, Ponil Creek	17,500
Patten Brook	3,000	Rayado River	15,000
Peters Brook	2,000	Urraca Lake	10,000
Prescott Brook	2,000	Cloudcroft, Bluewater Creek	10,000
Reid Brook	10,995	East Las Vegas, Calf Canyon Creek	5,000
Sweetwater Brook	3,000	Coyote River	15,000
Watts Brook	7,995	Gallinas River, South Fork	15,000
Whiting Brook	7,995	Gallinas River, Youngs Fork	7,500
Milford, New Boston Brook	6,000	Rio de la Casa	15,000
Osgood Brook	4,000	Winsor Creek	10,000
Nashua, Bartemus Brook	2,000	Three Rivers, Three Rivers, Branch of	7,500
Beaver Brook	6,460	Tularosa, Rio Ruidoso	15,000
Brick Yard Brook	4,920	Ute Park, Cimarron River	20,000
Budro Brook	2,000	New York:	
Chase Brook	2,000	Adams, Sandy Creek and branches	† 12,000
Crowell Brook	2,000	Albany, Emerich's ponds	† 15,000
Duval Brook	1,000	Ardsley, Grassy Sprain Brook	2,000
Flint Brook	2,000	Arena, Mill Brook	† 5,000
Ford Brook	1,000	Babylon, Sumpwam Brook	4,000
Four Corners Brook	1,230	Bangall, Cold Spring Brook	1,000
Glover Brook	3,000	Honey Meadow Brook	1,000
Greenleaf Brook	1,000	Warren Brook	1,200
Hardy Brook	3,000	Batavia, Mills Brook	† 2,000
Lyd Read Brook	2,000	Wolf Creek	† 3,000
Muddy Brook	2,000	Beaver River, Beaver River	† 10,000
Naticook Brook	3,000	Bessemer, Eddie Pond	† 1,000
Norman Howe Brook	2,000	Big Moose, Silver Lake	† 4,000
Old Maids Brook	1,000	Twitchell Lake	† 6,000
Peacock Brook	3,000	Brinckerhoff, Wickopee Creek	1,600
Peg Leg Brook	3,000	Cambridge, Camden Brook	5,000
Pemigewassett River	4,000	Jackson Brook	1,000
Riverside Farm Brook	1,000	Lowrie Brook	2,000
Robinson Brook	2,920	Maynard Brook	2,000
Second Brook	3,000	Owl Kill Brook	5,000
Silver Spring Brook	3,000	Sherman Brook	3,000
Smalls Brook	3,000		
Witch Brook	6,000		
Newbury, Lake Sunapee	18,000		

Total Distribution of Fish and Fish Eggs, by Species, Fiscal Year 1919—Continued.

BROOK TROUT—Continued.

Disposition.	Number.
New York—Continued.	
Carter, Bear Pond	†4,000
Lake Kora	†5,000
Sagamore Lake	†5,000
Catskill, Black Brook	†1,750
Haines Brook	†1,750
Kirkstown Creek	†1,750
Saxes Brook	†1,750
Shinglekill Creek	†3,500
Sicely Brook	†1,750
Voss Kill Creek	†1,750
Whippoorwill Brook	†1,750
Whitcomb Brook	†1,750
Cattaraugus, Finch Brook	†2,000
Wallace Brook	†2,000
Clayton, Frontenac Crystal Springs Pond	†1,000
Cobleskill, Charlotteville Creek	†5,000
Cobleskill Creek	†7,500
Cole Hollow Brook	†5,000
Dibble Hollow Brook	†5,000
East Worcester Creek	†7,500
West Creek	†5,000
West Fulton Creek	†5,000
West Middleburg Creek	†2,500
Cranberry, Cranberry Creek	†7,500
Elmira, Baldwin Creek	†4,000
Banfield Creek	†4,000
Beaver Brook	†2,000
Catherine Creek	†5,000
Cornish Creek	†4,000
Cranberry Creek	†3,000
Goldsmith Creek	†3,000
Horsehead Canal	†2,000
Jackson Creek	†4,000
Miller Brook	†2,000
Newtown Creek	†7,000
Seeley Creek	†8,000
Sing Sing Creek	†6,000
Smith Creek	†3,000
Texas Creek	†3,000
Wynkoop Creek	†4,000
Forestport, Little Woodhull Creek	†3,000
Gabriels, Buck Pond	†4,000
Clear Pond	†5,000
Rice Brook	†3,000
St. Regis River	†7,000
Genoa, Fred Green Creek	†2,000
Gamel Creek	†3,000
Pine Hollow Creek	†3,000
Groton, Owasco Creek	†5,000
Hopewell Junction, Wortlekill Creek	2,400
Hoosac Falls, Shingle Hollow Creek	3,000
White Creek	2,000
Hunters, Batavia Kill Creek	†7,500
Ithaca, Newfield Creek	†4,000
South Danby Creek	†5,000
Stratton Creek	†5,000
Lacona, Deer Creek	†5,000
La Fargeville, Cold Creek	†2,000
Lake Clear, Chub River	†4,000
Lake Plains, AuSable River	†10,000
Liberty, Neversink River	†2,500
Neversink River, East Branch	†2,500
White Sulphur Creek	†2,500
Long Lake West, Bear Pond	†4,000
Charley Pond	†2,000
Loon Pond	†8,000
Lyons, Glenmart Creek	†4,000
Mudge Creek	†4,000
Malone, Deer River	†5,000
Hatch Creek	†5,000
Trout River	†6,000
Millbrook, Bubbs Hollow Run	2,400
Howards Pond	1,600
Montour Falls, Glen Creek	†2,000
Spring Brook	†3,000
Sullivan Glen Brook	†1,000
New York, Aquarium	*5,000
New York—Continued.	
North Ilion, Steele Creek	†7,000
North Lansing, Glenn Smith Creek	†3,000
Gulf Creek	†3,000
Teeter Creek	†3,000
Northville, Buckhorn Pond	†7,500
Oneida, Oneida Creek	†8,000
Sconodoa Creek	†7,000
Oneonta, Charlotte River	†12,500
Oswego, Carpenter Creek	†4,000
Pawling, Swamp River	6,400
Pittsford, Lily Pond	†2,000
Port Henry, Cheeney Pond	3,000
Sand Pond	2,500
Trout Pond	2,500
Port Jervis, Bushkill Brook	†2,500
Mongaup River	†7,500
Shinglekill Brook	†2,500
Steinkill Creek	†2,500
Potsdam, Clear Pond	†5,000
Preble, Tioughnioga River	†5,000
Quaker Bridge, Creeks Run	†3,000
Hotchkiss Run	†4,000
Pierce Run	†3,000
Quaker Run	†5,000
Richland, Salmon River, North Branch	†6,000
Rome, Fish Creek, East Branch	†12,000 2,000
Salamanca, Morton Pond	†1,000
Prosser Pond	†3,000
Santa Clara, Deep Pond	†3,000
Deer Pond	†2,000
Dimmick Brook	†3,000
Goose Pond Brook	†3,000
Guide Board Brook	†2,000
Spring Pond	†1,000
Saugerties, Plattekill Creek	†5,000
Reservoir Creek	†5,000
Schenectady, Poentic Kill Creek	†5,000
Schenevus, Elk Creek	†12,500
South Lansing, Ernest Teeter Creek	†2,000
Steinburg Creek	†3,000
Stateline, Indian Brook	6,000
Syracuse, Bear Creek	†4,000
Bear Trap Brook	†3,000
Bishop Brook	†2,000
Butternut Creek	†4,000
Carpenter Pond Brook	†3,000
Chittenango Creek	†5,000
Fabius Brook	†4,000
Fellows Brook	†2,000
Geddes Brook	†6,000
LaFayette Creek	†6,000
Manlius Brook	†2,000
Melvins Pond	†500
Onondaga Creek, West Branch	†2,000
Peck Brook	†2,000
Pools Brook	†8,000
Redhead Brook	†2,000
South Hollow Brook	†6,000
Spofford Brook	†8,000
Stony Brook	†7,000
Swamp Brook	†4,000
Van Bergen Brook	†2,000
Tappan, Palisades Creek	1,600
Utica, Homer City Brook	†3,000
Voorheesville, Cold Springs Creek	†5,000
New Scotland Creek	†10,000
Walton, Beers Brook	†2,500
Bramley Brook	†2,500
Chase Brook	†2,500
Dryden Brook	†2,500
East Brook	†2,500
Hinman Hollow Brook	†2,500
Kerrs Creek	†2,500
Mallory Brook	†2,500
Marvin Hollow Brook	†2,500
Oxbow Hollow Brook	†2,500

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

BROOK TROUT—Continued.

Disposition.	Number.
New York—Continued.	
Walton, Pines Brook	†2,500
Third Brook	†2,500
Trout Brook	†12,500
Wakeman Brook	†2,500
Whitehall, Castle Creek	2,000
Cold Brook	2,000
Pike Brook	2,500
Woods, Cranberry Pond	†3,000
Razor Back Pond	†4,000
Woods Lake	†3,000
North Carolina:	
Asheville, Mineral Creek	10,500
Canton, Crawford Creek	6,000
Daniels Creek	6,000
Dillard, Big Creek	5,400
Mill Creek	3,600
Satulah Creek	3,600
Shoal Creek	3,600
Slab Camp Branch	3,600
Wildcat Lake	3,600
Ela, Cooper Creek	3,000
Little Creek	3,000
Etowah, Willow Creek, South Prong	4,500
Foscoe, Dixon Creek	6,000
Horseshoe, North Mills River and branches	17,500
Lake Toxaway, Bear Wallow Creek	11,400
French Broad River, East Fork	7,200
Indian Creek	4,500
Shoal Creek	4,500
Lenoir, Anthony Creek	10,500
Lost Cove Creek	3,000
Linville, Big Grassy Creek	5,000
Grandmother Creek	6,000
Kawana Lake	3,000
Linville River	10,000
Linville River, West Fork	5,000
Little Grassy Creek	5,000
Micaville, South Toe River	8,000
Newland, Squirrel Creek	6,000
Pisgah Forest, Davidson River and branches	26,000
South Mills River	26,500
Poplar, Pigeon Roost Creek	7,500
Samarcand, Drowning Creek, Middle Branch	5,400
Tuxedo, Grassy Creek	5,400
Grassy Creek, Briar Fork	5,400
Jims Creek	5,400
Rock Creek	5,400
Ohio:	
Canton, Nimisillen Creek	2,500
Mansfield, Coles Brook	2,000
Urbana, Cedar Creek	3,000
Oregon: Clackamas, Clackamas River	50,400
Pennsylvania:	
Austin, Big Moores Run	1,000
Freeman Run	1,000
Little Moores Run	1,000
Nelson Run	1,000
Prouty Run	1,000
South Fork Run	1,000
Blairs Mills, Horse Valley Run	5,000
Boiling Springs, Broad Run	6,000
Old Town Run	6,000
Burrows, Pine Creek, West Branch	1,500
Cairnbrook, Beaver Run	5,000
Carbondale, Lyon Creek	1,800
Coburn, Fishing Creek	3,000
Horner House Run	2,000
Phillips Creek	3,000
Pine Creek	2,000
Poe Creek	2,000
Sinking Creek	2,000
Spring Bank Run	2,000
Synagogue Creek	2,000
Turpentine Run	2,000
Winklebleak Run	2,000
Pennsylvania—Continued.	
Coudersport, Baker Creek	800
Clark Creek	400
Dingman Run and branches	1,600
Dry Run	800
Dwight Creek	400
Earl Run	400
Ellison Run	400
Elm Run	800
Fee Run	400
Gordon Run	400
Graves Run	400
Howland Run	400
Kent Run	400
Kline Run	400
Knowlton Run	400
Lehman Run	400
Leet Run	400
Lent Run	400
Lewis Run	400
Mill Creek and branches	2,000
Mitchell Creek	400
Mosier Run	400
Nelson Run	800
Niles Run	400
Potter Run	400
Prosser Run	400
Reed Run	800
Reese Run	400
Rock Run (A)	400
Rock Run (B)	400
Sherwood Run	400
Steer Run	400
Thompson Run	400
Trout Run	800
Veley Run	800
Wadsworth Run	400
White Run	400
Curry, Three Spring Run	3,000
Downingtown, Broad Run	3,000
Easton, Browns Creek	500
Bushkill Creek	1,500
Durham Creek	500
East Petersburg, Erbs Run	1,000
Grosh Run	3,000
Hostetter Run	3,000
Snipe Creek	3,000
Ebensburg, Barker Run	2,000
Blacklick Run	3,000
Little Conemaugh Creek	3,000
Roaring Run	5,000
Shady Creek	2,000
Stewart Run	2,000
Tudor Run	2,000
Emporium, Big Run	400
Bobby Run	400
Canoe Run	400
Chop Run	400
Clear Creek	800
Cook Run	800
Driftwood Run	1,600
East Cowley Creek	400
Finley Run	800
Five Mile Run	400
Four Mile Run	400
Half Mile Run	800
Hunts Run	800
Hunts Run, McKennon Branch	400
Lewis Run	800
Little Hunts Run	800
Nickays Run	400
North Creek	800
Parker Run	800
Portage Creek	800
Robinson Run	400
Rock Run	800
Sterling Run	800
Waldy Run	800
West Creek	1,200

Total Distribution of Fish and Fish Eggs, by Species, Fiscal Year 1919—Continued.

BROOK TROUT—Continued.

Disposition.	Number.	Disposition.	Number.
Pennsylvania—Continued.		Pennsylvania—Continued.	
Emporium, West Cowley Creek	800	Philipsburg, Little Beaver Run	1,000
Farrandsville, Lick Run	3,000	Moravian Run	2,000
Garret, Brush Creek	8,000	Shields Run	1,000
Wares Run	2,000	Six Mile Run	2,000
Glen Mawr, Kettle Creek	2,000	Smays Run	2,000
Ogdonia Creek	2,000	Stanton Run	1,000
Rock Run	1,500	Star Run	2,000
Glen Union, Baker Run	3,000	Tomahawk Run	3,000
Mill Run	3,000	Tom Tit Run	1,000
Scootac Creek, North Fork	3,000	Trout Run (A)	1,000
Scootac Creek, South Fork	3,000	Trout Run (B)	1,000
Glynden, Britton Run	800	Phoenixville, Mashalmac Creek	1,000
Green Point, Trout Run, Northwest Branch	3,000	Reading, Willow Creek	3,000
Indiana, Ray Run	5,000	Renovo, Halls Run	1,600
Stake Run	4,000	Two Mile Run	1,600
Lemont, Branch Creek	3,000	Young Womans Creek	1,600
Center Furnace Branch	2,000	Rockport, Indian Run	2,000
Collier Run	2,000	Scranton, Lake Sheridan Creek	500
Fair Run	2,000	Somerfield, Beaver Creek	4,000
Rock Spring Creek	5,000	Tub Run	1,600
Shingletown Creek	2,000	Sonestown, Eagles Mere Creek	1,000
Sinking Creek	4,000	Trout Run, Dougherty Run	1,000
Slab Cabin Creek	3,000	Wolf Run	1,000
Spring Creek	3,000	Troy, Bullard Creek	500
Stone Creek	4,000	Bullard Creek, North Branch	500
Lewistown, Knepps Run	3,000	Covert Run	500
Mountain Spring Run	1,000	Dry Run	500
Listonburg, Whites Creek	2,800	Factory Run	500
Manns Choice, Breastwork Run	5,000	Griffin Creek	500
Fyan Run	5,000	Kiff Run	500
Laurel Run	5,000	Leona Creek	500
Marietta, Charles Run	4,000	Little Falls Creek	500
Collins Creek	4,000	Lye Run	500
Donegal Creek	4,000	Morgan Creek	500
Gladfelter Run	2,000	Morgan Creek, North Branch	500
Mifflin, Solouff Run	2,000	Porter Creek	500
Mill Hall, Cedar Run	6,000	Sugar Creek, North Branch	500
Cherry Run	3,000	Tioga River	1,500
Fishing Creek	15,000	Uniontown, Chaney Run	800
Fox Hollow Run	2,000	Laurel Run	800
Plum Run	4,000	Mill Run	1,200
Little Bear Creek	1,500	Rock Run	800
Montoursville, Ocdonice Run	2,000	Walnutport, Wild Creek	5,000
Wallis Run	2,500	Waterville, Canoe Bottom Run	1,200
Mount Union, Long Hollow Run	5,000	Pine Bottom	1,800
Muncie, Turkey Run	1,000	Waynesboro, Cress Creek	2,000
Oil City, Norway Run	1,000	Whiteland, Lionville Run	3,000
Orviston, Big Run	2,000	Whiteland Run	7,000
Eddy Lick Run	2,000	Williamsport, Big Bear Creek	1,500
Hays Run	2,000	Dry Run	1,000
Paddy Mountain, Penns Creek	4,000	Hoagland Run	1,500
Pen Argyl, Bushkill Creek	500	Hoagland Run, Sandy Branch	1,500
Cherry Valley Creek	500	Learys Creek, Spooners Branch	1,000
Green Walk Creek	500	Wolf Run	1,500
Reynolds Creek	500	Windber, Berkebyle Run	3,000
Ross Common Creek	500	Biscuit Spring Run	2,000
Ross Valley Creek	500	Clear Shade Creek	7,000
Spruce Run	500	Cub Run	1,000
Penn Haven Junction, Drakes Creek	3,000	Mauger Run	2,000
Philipsburg, Alder Run	2,000	Mickel Run	3,000
Ardel Run	1,000	Mill Creek	1,000
Barker Run	1,000	Miller Run	3,000
Bark Shed Run	1,000	Muncie Creek	1,000
Beaver Meadow Run	1,000	Ober Run	3,000
Bemer Run	1,000	One Mile Run	1,000
Benners Run	2,000	Piney Run	6,000
Bigelow Run	1,000	Roaring Fork Run	5,000
Bilger Run	1,000	Seese Run	3,000
Black Bear Run	2,000	Shingle Run	2,000
Black Moshanon Creek	3,000	Tub Run	4,000
Cold Creek	2,000	Whitaker Run	2,000
Dayton Run	1,000	York, Conewago Creek	8,000
Forge Run	3,000	Youngdale, McElhattan Run	1,500
Four Mile Run	2,000	Rhode Island:	
Hutton Run	1,000	Greene, Bear Brook	6,000
Huzzard Run	1,000	Bullock Brook	6,000
Little Barker Run	1,000	Cottrell Brook	6,000
		Fall River Brook	6,000

Total Distribution of Fish and Fish Eggs, by Species, Fiscal Year 1919—Continued.

BROOK TROUT—Continued.

Disposition.	Number.
Rhode Island—Continued.	
Greene, Muddy Brook	6,000
Providence, Cork Brook	4,800
Roaring Brook	6,000
Spruce Brook	4,800
Tomaquog Brook, East Branch	3,600
Tomaquog Brook, West Branch	4,800
South Carolina: Pickens, Surveyors Camp Creek	7,200
South Dakota:	
Custer, French Creek	8,000
Deadwood, Trucanos Pond	1,500
Elmore, Hanna Creek	3,000
Spearfish Creek	6,000
Englewood, California Gulch Creek	1,200
Little Spearfish Creek	6,000
Peak Creek	10,000
Spearfish Creek, South Branch	1,200
Wildcat Gulch Creek	3,000
Fairburn, French Creek	6,000
Galena Creek	4,000
Squaw Creek	6,000
Hermosa, Iron Creek	6,000
Hill City, Battle Creek	10,000
Newtons Fork Creek	8,000
Palmer Gulch Creek	6,000
Patterson Gulch Creek	5,000
Spring Creek	20,000
Sunday Gulch Creek	5,000
Ice Box Canyon, Spearfish Creek	7,200
Keystone, Battle Creek	3,000
Nahant, Little Rapid Creek	16,000
Tilson Creek	7,000
Nemo, Box Elder Creek	30,000
Este Creek	3,000
McCall Creek	1,000
Pine Ridge, Porcupine Creek	13,500
White Clay Creek	4,500
Wolf Creek	2,500
Pringle, Beaver Creek	29,000
Rapid City, Antlers Creek	1,000
Box Elder Creek	6,000
Cedar Creek	500
Cottonwood Creek	1,000
Deer Creek	3,000
Electric Light Pond	2,000
Fairground Lake	1,000
Indian School Lake	1,000
Jim Creek	3,000
Lime Creek	2,000
Lockhart Pond	1,000
Murray Pond	1,000
Nugget Creek	3,000
Prairie Creek	3,000
Rapid Creek and branches	41,650
Rounds Pond	1,000
Schambers Creek	1,000
Schambers Pond	1,000
Scotts Pond	1,000
Sickler Pond	1,000
Slate Creek	4,000
Spring Creek	6,000
Victoria Creek	4,000
Rochford, Castle Creek	6,000
Jim Creek	3,000
Peterson Pond	500
Riley Pond	1,000
Webber Pond	1,500
Savoy, Little Spearfish Creek	4,000
Nursery Pond	19,000
Spearfish, Bill Cook Creek	4,000
Bridal Veil Creek	8,000
Camp Three Branch	2,000
Castle Rock Creek	5,000
Chicken Creek	5,000
City Creek	6,200
Coxes Lake	3,000
Coxes Lake Creek	4,000
Crago Branch	1,500
South Dakota—Continued.	
Spearfish, Creamery Pond	1,000
Cress Creek	2,000
Dedrock Spring Branch	1,500
Driskill Creek	2,000
Ernest Branch	2,000
Farmer Jones Creek	2,400
Higgins Gulch Creek	5,000
Henwood Branch	4,500
Lindley Spring Branch	4,800
McGreager Creek	7,250
McVeys Creek	5,000
Meadow Creek	800
Mill Creek	2,000
Mordau Creek	7,750
Oak Spring Creek	750
Oak Spring Pond	3,750
Owens Creek	1,500
Park Creek	2,000
Pettigrew Creek	2,000
Red Water Creek	18,000
Riverview Branch	5,000
Schmidt Creek	2,000
Spearfish Creek	20,000
Stucco Creek	3,000
Summers's Pond	2,000
Toomey Creek	1,000
Town Creek	6,000
Willow Creek	4,000
Sturgiss, Bear Butte Creek	24,000
Deadman Creek	4,000
Tilford, Morris Creek	3,500
Vetal, Cedar Creek	5,000
Little White River	15,000
Tennessee: Elkmont, Jakes Creek	6,750
Utah:	
Burrville, Small Creek	2,500
Fish Lake, Fish Lake	18,500
Payson, Payson Creek	2,500
Spring Lake	2,500
Provo, Provo River	26,800
Richfield, Fish Lake	13,500
Springville, Hobble Creek	12,000
Thistle, Thistle Creek	2,000
Vermont:	
Barre, Martin Brook	†2,000
Barton, May Pond	†3,000
Bennington, Basin Brook	†7,445
Bates Brook	†6,445
Battenkill River	†4,000
Bickford Hollow Brook	†7,450
Burgess Brook	†5,450
Bushnell Brook	†5,445
Chase Brook	†4,450
Dewey Brook	†1,000
Duck Pond Brook	†5,450
Dunville Brook	†5,445
Evans Brook	†4,450
Furnace Lake Brook	†5,445
Glastenbury Brook	†8,445
Hatchery Brook	†2,000
Little Hell Hollow Brook	†6,450
North Bennington Pond Brook	†3,000
Perry Thompson Brook	†6,445
Rake Branch	†3,000
Rider Brook	†7,450
Rockwood Brook	†5,445
School Brook	†5,445
Stratton Brook	†6,450
Warm Brook	†8,445
Webb Brook	†7,450
Brattleboro, South Pond	1,000
Burlington, applicant	*2,000
Canaan, Averill Brook	†7,000
Big Averill Lake	†4,000 400
Black Brook	†6,000
Cole Brook	†8,000
East Brook	†9,000

Total Distribution of Fish and Fish Eggs, by Species, Fiscal Year 1919—Continued.

BROOK TROUT—Continued.

Disposition.	Number.
Vermont—Continued.	
Canaan, Forest Brook	†6,500
Forest Lake	†3,000
	200
Lewis Lake	†2,000
	200
Little Averill Brook	†6,000
Little Averill Lake	†3,000
	200
Morrill Brook	†7,000
Norton Lake	†3,000
	1,000
Nulhegan River	†10,000
Number Six Brook	†8,000
Roaring Brook	†6,500
Second Black Brook	†5,000
Swanson Brook	†9,000
Yellow Brook	†7,000
Danville, Joes Brook	†5,000
Edgewater, Niggerhead Ledge Brook	†2,000
Ely, Bannock Brook	200
Groton, Darling Pond	†50,000
	17,426
Hardwick, Abutment Brook	†1,000
Bailey Brook	†2,000
Bell Brook	†1,000
Bunker Brook	†2,000
Collier Brook	†1,000
Cold Spring Brook	†1,000
Cooper Brook	†2,000
Currier Brook	†1,000
Foss Brook	†3,000
High Trestle Brook	†2,000
Keeler Brook	†2,000
Lake Wapanacki	†1,000
Lake Wapanacki Brook	†1,000
Laundry Brook	†1,000
Norris Brook	†1,000
Paine Brook	†2,000
Pierce Brook	†1,000
Porter Brook	†3,000
Tucker Brook	†2,000
Warren Brook	†1,000
Holden, Bassett Brook	†2,000
Beaver Brook	1,000
Billings Brook	1,000
Clover Vale Brook	†4,000
Coal Kiln Brook	†5,000
Coburn Brook	†2,500
Fitzgerald Brook	700
Furnace Brook and branches	†22,000
Horton Brook	1,000
Lefferts Pond	1,500
Ore Bed Brook	†2,000
Osgood Brook	1,000
Randall Brook	†2,500
Ripley Brook	1,000
Sand Spring Brook	†3,000
School House Brook	1,000
Spring Lake	525
Sugar Hollow Brook	†3,000
Valley View Brook	†2,000
Wardwell Brook	1,000
Willow Brook	†2,000
Hyde Park, Hyde Pond	†1,000
Lunenburg, Baker Brook	†1,000
Mallet Brook	†1,000
Mink Brook	†4,000
Lyndonville, Pond Brook	†5,000
Manchester, Battenkill River, West Branch	†5,000
Manchester Depot, Battenkill River	†8,000
Boom Pond	†5,000
Marshfield, Beaver Pond	†2,000
Middlesex, Great Brook	†3,000
Panhandle Brook	†2,000
Morrisville, Billings Brook	†5,000
Bugbee Brook	†2,000
Copper Brook	†2,000
Vermont—Continued.	
Morrisville, Darling Brook	†2,000
Green River	†5,000
Hatch Brook	†1,500
Hazen Brook	†2,000
McNall Brook	†4,000
Potash Brook	†2,000
Shippy Brook	†1,500
Smith Brook	†2,000
Terrell Brook	†4,000
Newport, Buck Brook (A)	†2,000
Buck Brook (B)	†2,000
Center Brook	†3,000
Day Brook	†2,000
Holton Brook	†2,000
Jud Brook	†2,000
Kidder Brook	†2,000
Lang Brook	†4,000
Larabee Brook	†2,000
Orcutt Brook	†2,000
Papenaw Brook	†2,000
Tice Brook	†2,000
Turtle Pond	†2,000
Ware Brook	†2,000
Watson Brook	†2,000
Norwich, Lake Mitchell	†80,000
Orleans, Donaldson Brook	†2,000
Dunham Brook	†2,000
Dutton Brook	†2,000
Gallup Brook	†3,000
Hannat Brook	†2,000
Hog Trough Brook	†2,000
Irasburg Brook	†2,000
Joslyn Brook	†2,000
Long Pond	†6,000
Matthews Brook	†2,000
Nigger Pond	†3,000
Parlin Brook	†2,000
Wiggins Brook	†2,000
Willoughby River	†6,000
Wyman Brook	†2,000
Pittsford, Johnsons Pond	500
Plainfield, Carr Brook	†1,000
Kingsbury Brook	†2,000
Peacham Pond	†5,000
Randolph, Adams Brook	†2,000
Annis Brook	†1,500
Ayers Brook	†3,500
	300
Bass Brook	†1,000
Bear Hill Brook	†2,000
Beedles Pond	†1,000
	300
Blanchard Brook	†1,000
Bowman Brook	†1,500
Chandler Brook	†2,000
Clough Brook	†2,000
Fishers Brook	†1,500
Guild Brook	†1,500
Gulf Brook	†500
Holman Brook	†1,500
Howard Hill Brook	†2,000
Mann Brook	†1,000
Meadow Brook	†2,500
Morse Brook	†1,000
Mud Pond	†3,000
Peth Brook	†2,000
Poverty Lane Brook	†2,000
Riford Brook	†3,000
Roaring Brook	†1,500
Roods Brook	†1,000
Roxbury Brook	†2,000
Soper Brook	†1,500
Spears Brook	†3,000
Taber Brook	†1,000
Roxbury, East Warren Brook	1,500
Mad River	2,500
Stetson Brook	1,000
Rutland, Phalen Brook	†2,000

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

BROOK TROUT—Continued.

Disposition.	Number.
Vermont—Continued.	
Rutland, Wheeler Brook	†3,000
Williams Brook	†3,000
St. Johnsbury, Bacon Brook	†4,000
Carpenter East Brook	†2,000
Carpenter West Brook	†2,000
Cold Brook	†4,000
Gage Brook	†6,000
Hasting Brook	†5,000
Hawkins Brook	†7,000
Joes Brook	†15,000
Meadow Brook	†1,000
Moose River	†18,000
Parker Pond	†3,000
Pierce Brook	†3,000
Roberts Brook	†3,000
Sleepers River	†3,000
Spaulding Brook	†4,000
Walter Andrick Brook	†14,000
Wright Brook	†3,000
St. Johnsbury Center, Richards Brook	†1,000
King Brook	†5,000
Sharon, Standing Pond	300
Sheldon Junction, Adams Pond	1,000
Bakersfield Brook	2,000
Cold Hollow Brook	2,000
County Brook	1,000
Ladd Trout Brook	1,000
Mineral Spring Brook	1,000
Pat Brady Brook	2,000
St. Johns Brook	1,000
Stoneville Brook	1,000
South Royalton, Alco Pond	†3,000
South Ryegate, Baleys Pond	†500
Long Pond	†1,000
Muddy Pond	†2,500
Scott Brook	†4,000
Wallingford, Maxhams Brook	†2,000
Roaring Brook	†3,000
Wells River, Wells River	†10,000
West Hartford, Meadow Brook	†2,000
Rockland Brook	†2,000
Williamstown, White River, branch of	†2,000
Woodstock, Beaver Meadow Brook	†2,000
Gallup Brook	†2,000
Kedron Brook	†3,000
North Bridgewater Brook	†1,000
Ottauguechee River	†6,000
South Barnard Brook	†3,000
South Pomfret Brook	†3,000
Virginia:	
Barbours Creek, Barbours Creek	1,500
Buena Vista, Chalk Mine Run	2,000
Indian Gap Run	1,000
Lowerys Run	3,000
Robinson Branch	2,000
Buffalo Forge, Belle Cove Creek	2,000
Byllesby, Chestnut Creek	3,000
Charlottesville, Buck Mountain Creek	6,300
East Falls Church, Four Mile Run	150
Holmes Run	150
Elkton, Green Meadow Pond	1,000
Fairwood, Wilson Creek	4,000
Galax, Goodson Creek	3,000
Laurel Branch	2,000
Harrisonburg, Dry River	3,000
Hunters, Rocky Run	200
Lorton, Charles Run	400
Mount Solon, Briery Branch	625
Natural Bridge, Elk Creek	6,000
Hell Gate Creek	3,000
Pearisburg, Sugar Run	1,000
Purcelle, Reed Creek	6,000
Riverside, Stony Creek	2,000
Snowden, Cashaw Creek	2,000
Staunton, Ramseys Run	7,000
Virginia—Continued.	
Stokesville, Briery Branch	3,000
Little River	3,500
North River	3,875
Sugar Grove, Panther Creek	3,000
Vienna, Little Difficult Run	6,000
Troutdale, Big Fox Creek	3,000
Little Laurel Creek	2,000
Mill Creek	5,000
Ripshine Creek	1,000
Woodstock, Little Stony Creek	2,000
Washington:	
Boyds, Sherwood Creek	350
Everett, Martha Lake	7,000
Oakville, Cedar Creek	7,000
Stevenson, applicant	*50,000
West Virginia:	
Alexander, Buchanon River, Left Fork	15,000
Beverly, Files Creek	400
Davis, Blackwater Creek	11,000
Elkins, Cross Run	300
Isner Run Laurel Branch	300
Grafton, Wells's Pond	800
Hambleton, Elk Lick Creek	3,000
Otter Creek	4,000
Roaring Run	2,000
Hendricks, Otter Creek	600
Holcomb, Holcomb Run	4,000
Horton, Gandy Creek	8,000
Lumber, Spruce Run	200
Wolf Run	200
Marlington, Elk River	12,000
Midvale, Tygarts River, Middle Fork	126,000
Mill Creek, Tygarts Valley River	55,400
Moorefield, Turn Mill Run	4,000
Morgantown, Quarry Run	9,000
Newlon, Buchanon River, tributary of	15,000
Parsons, Mill Run	300
Reedsville, Fields Creek	2,000
Richwood, Big Rocky River	7,000
Cherry River, North Fork	15,000
Cherry River, South Fork	15,000
Cold Knob Fork Creek	7,000
Hunters Run	7,000
Improvement Run	5,000
Little Laurel Creek	10,000
Panther Creek	15,000
Sitlington, Sitlington Creek	8,000
Stony Bottom, Woods Run	300
Terra Alta, Elseys Run	4,000
Thomas, Blackwater River	600
Blackwater River, North Fork	3,000
Laurel Run	1,000
North Branch	600
Wildell, Greenbrier River	7,800
Winterburn, Greenbrier River	5,000
Little River	5,000
Wisconsin:	
Adams, Duck Creek	1,000
Jackson Creek	2,000
Schoonover Creek	1,000
Algoma, Black Ash Creek	2,000
Alma, Beef Valley Creek	2,000
Cream Creek	2,000
Eagle Creek	2,000
Johns Creek	2,000
Johns Valley Creek	2,000
Little Waumandee Creek	2,000
Norwegian Valley Creek	1,000
Waumandee Creek	1,000
Wolf Creek	1,000
Antigo, Kennedy Creek	1,000
Schmitz Creek	1,000
Arcadia, American Valley Creek	1,000
Bulls Valley Creek	1,000
Eagle Valley Creek	1,000
Eagle Valley Creek, North Branch	1,000

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

BROOK TROUT—Continued.

Disposition.	Number.	Disposition.	Number.
Wisconsin—Continued.		Wisconsin—Continued.	
Arcadia, English Creek	1,000	Cumberland, Sand Creek	†3,000
Gilmore Valley Creek	1,000	Dodgeville, Brewery Branch	800
Haines Creek	1,000	Conley Creek	800
North Creek	3,000	Dodge Branch	1,600
Riley Creek	1,000	Edmunds Branch	1,600
Rohn Valley Creek	2,000	Jones Branch	800
Spring Creek	1,000	Meudt Creek	1,600
Spring Valley Creek	1,000	Smith Bros. Branch	2,400
Thomas Valley Creek	1,000	Treborville Branch	3,200
Travis Valley Creek	1,000	Yeagers Creek	800
Trout Creek	1,000	Donaldson, Spring Creek	2,500
Wichen Valley Creek	1,000	Tamarac Creek	3,000
Augusta, Bear Grass Creek	580	Eau Claire, Bessie Creek	290
Beef River and branches	2,900	Clara Creek	290
Bridge Creek	580	Grace Creek	580
Browns Creek	290	Sand Creek	290
Coon Gut Creek	290	Shady Creek	580
Hathaway Creek	290	Willow Creek	290
Hay Creek	290	Edmund, Furnace Hollow Creek	1,600
Sand Creek	290	Spring Valley Creek	2,400
Whippoorwill Creek	290	Eleva, Adams Creek	1,000
Barneveld, Jones Creek	2,400	Anderson Creek	1,000
Smith Branch	2,400	Bemet Valley Creek	2,000
Trout Creek	3,200	Big Creek	2,000
Walnut Hollow Creek	4,000	Bollinger Creek	1,000
Black River Falls, Douglas Creek	1,000	Crystal Creek	1,000
Kenyon Creek	1,000	Hawkinson Valley Creek	1,000
Perry Creek	2,000	Haze Valley Creek	1,000
Roaring Creek	2,000	Hoven Creek	1,000
Sand Creek	2,000	Lindsay Creek	1,000
Slosser Creek	1,000	Rossman Creek	2,000
Snow Creek	1,000	Tollefson Creek	1,000
Squaw Creek	1,000	Trout Creek	1,000
Town Creek	1,000	Elk Mound, Beaver Dam Creek	290
Trout Creek	1,000	Fond du Lac, Dotyville Creek	2,000
Blair, Lake Coulee Creek	2,000	Eden Creek	2,000
Peterson Creek	1,000	Gans Creek	2,000
Trump Coulee Creek	2,000	Hinn Creek	1,000
Bloomer, Duncan Creek	290	Hobbs Creek	1,000
Hay Creek	290	Mulvey Creek	2,000
McCann Creek	290	Rock Creek	1,000
Sand Creek	290	Stroup Creek	1,000
Stevens Creek	290	Fountain City, Bohris Valley Creek	1,000
Trout Creek, North Fork	580	Eagel Valley Creek	1,000
Blue Mounds, Austin Creek	800	Freid Valley Creek	1,000
Camp Creek	800	Huber Creek	1,000
Garfoot Creek	800	Pipers Valley Creek	1,000
Walnut Hollow Creek	800	Schaffner Valley Creek	1,000
Boscobel, Coon Branch	1,600	Grand Marsh, White Creek	3,000
Brandon, Rock River, tributary of	2,000	Grand Rapids, Drainage Creek	3,000
Bruce, Alder Creek	1,160	Five Mile Creek	2,000
Brule, Little Brule River	3,000	Harvey Creek	2,000
Cashton, Berens Creek	1,000	Lynn Creek	1,000
Bohemian Creek	1,000	Seven Mile Creek	2,000
Brush Creek	1,000	Spring Branch	2,000
Cannon Valley Creek	1,000	Two Mile Creek	2,000
Coles Valley Creek	1,000	Wakeley Creek	2,000
Hagen Creek	1,000	Hatfield, Visnow Creek	2,000
Halls Valley Creek	1,000	Hawkins, Manning Creek	870
Hay Hollow Creek	1,000	Skinner Creek, North Fork	870
Heiser Creek	1,000	Skinner Creek, South Fork	870
Houser Creek	1,000	Hayward, Mineola Creek	†4,500
Korn Spring Creek	1,000	Hazelhurst, Kitty Creek	500
Mansky Valley Creek	1,000	Rocky Creek	2,000
Mashak Creek	1,000	Hillsboro, Billings Creek	1,000
Morrison Creek	1,000	Hortonville, McNutt Creek	1,000
Oium Valley Creek	1,000	Mill Pond	2,000
Paulson Creek	1,000	Nordman Creek	1,000
Pleasant Valley Creek	1,000	Independence, Borst Creek	2,000
Russell Valley Creek	1,000	Bruce Creek	1,000
Timber Valley Creek	1,000	Bryn Creek	1,000
Twenty Four Mile Creek	1,000	Elk Creek	2,000
Chippewa Falls, Duncan Creek	870	Olson Creek	1,000
Paint Creek	870	Plumb Creek	1,000
Couderay, King Creek	1,000	Moskos Creek	1,000
Poer Creek	1,000	Kilbourn, Gilmore Creek	2,000
Weirgor Creek	2,000	La Crosse, Burns Valley Creek	3,000
Windfall Creek	1,000	Mormon Coulee Creek	†36,470

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

BROOK TROUT—Continued.

Disposition.	Number.
Wisconsin—Continued.	
Ladysmith, Badger Creek	290
Beaver Creek	290
Lone Pine Creek	580
Spring Creek	580
Laona, Rat River and tributaries	3,000
Mattoon, Wiese Creek	3,000
Menomonie, Adams Creek	1,000
Anderson Creek	1,000
Annis Creek	1,000
Asylum Creek	1,000
Big Beaver Creek	1,000
Big Elk Creek	1,000
Big Meadow Creek	1,000
Big Missouri Creek	1,000
Big Otter Creek	1,000
Biss Creek	1,000
Blair Creek	1,000
Bolin Creek	1,000
Bubbling Springs Creek	1,000
Cady Creek	1,000
Campbell Creek	1,000
Clacks Creek	1,000
Conners Creek	1,000
Coon Creek	1,000
Cranberry Creek	1,000
Crosby Creek	1,000
Dahl Creek	1,000
Drowley Creek	1,000
Dushane Creek	1,000
Eau Galle River	1,000
Eddy Creek	1,000
Eighteen Mile Creek	1,000
Enems Creek	2,000
Galloway Creek	1,000
Gilbert Creek	2,000
Hall Creek	1,000
Hay Creek and tributaries	4,000
Hobbs Creek	1,000
Honey Creek	1,000
Iron Creek	1,000
Irving Creek	1,000
Jesse Creek	1,000
Johns Creek	1,000
Johnson Creek	2,000
King Creek	1,000
Knights Creek	1,000
Lambs Creek	1,000
Lindsay Creek	1,000
Little Beaver Creek	1,000
Little Elk Creek	1,000
Little Missouri Creek	1,000
Little Otter Creek	1,000
Little Sand Creek	1,000
Losbys Creek	1,000
Lynch Creek	1,000
McArthy Creek	1,000
Mares Creek	1,000
Miller Creek	1,000
Mud Creek and tributaries	3,000
Owen Creek	1,000
Palmer Creek	1,000
Parker Creek	1,000
Pine Creek	2,000
Popple Creek	1,000
Proper Creek	1,000
Quarder Creek	1,000
Quilling Creek	1,000
Rock Creek	1,000
Rush Creek	1,000
Sand Creek	1,000
Shaffer Creek	1,000
Simonson Creek	2,000
Smith Creek	1,000
Spring Creek	1,000
Stoner Creek	1,000
Styer Creek	1,000
Thums Creek	1,000
Tiffany Creek	1,000
Wisconsin—Continued.	
Menomonie, Torgerson Creek	1,000
Trout Creek	1,000
Valley View Creek	1,000
Vance Creek	1,000
Varney Creek	1,000
Washburn Creek	1,000
Watterson Creek	1,000
Wilson Creek and tributaries	2,000
Wolf Creek	1,000
Merrill, Averill Creek	2,000
Barnes Creek	2,000
Big Hay Meadow Creek	2,000
Devils Creek	2,000
French Ridge Creek	2,000
Johnson Creek	2,000
Little Hay Meadow Creek	2,000
Pat Smith Creek	2,000
Pine River and tributaries	6,000
Prairie Creek	2,000
Millston, Covey Creek	1,000
Glen Creek	1,000
Jacobs Creek	1,000
Lambert Creek	1,000
LaPoint Creek	1,000
Larkin Creek	1,000
Mile Creek	1,000
Patterson Creek	1,000
Pigeon Creek	1,000
Pongratz Creek	1,000
Pump House Creek	2,000
Robinson Creek	2,000
Rocky Creek	1,000
Second Creek	1,000
Stanton Creek	1,000
Wyman Creek	2,000
Minocqua, Davidson Creek	500
Howard Creek	1,500
Kitty Creek	1,500
Little Tomahawk Creek	1,500
Pine Creek	1,500
Scotchman Creek	1,000
Shampine Creek	1,000
Three Mile Creek	1,000
Mount Horeb, Aavang Creek	800
Bohn Creek	3,200
Dolhantry Creek	2,400
East Blue Mounds Creek	800
East Branch	800
Haakeness Creek	2,400
Klevenville Creek	1,600
Lubmann Creek	1,600
Mount Horeb Branch	1,600
Noon Creek	800
Springdale Creek	800
Vermont Creek	2,400
Muscoda, Byrds Creek	1,600
Coon Creek	2,400
Fox Hollow Creek	800
Gault Hollow Creek	1,600
Hoosier Creek	2,400
Indian Creek	800
Jurgerson Branch	800
Kinsing Creek	1,600
Ludwig Creek	2,400
Sand Creek	800
Shemake Creek	800
Six Mile Creek	2,400
Studnicka Branch	800
Neenah, Herziger's pond	1,000
New Lisbon, Brewer Creek	500
Diller Creek	2,000
Fountain Creek	500
Little Lemonweir River	1,500
Macomber Creek	1,000
Meads Creek	500
Richard Creek	2,000
Webster Creek	2,000
Norwalk, Roy Creek	5,000

Total Distribution of Fish and Fish Eggs, by Species, Fiscal Year 1919—Continued.

BROOK TROUT—Continued.

Disposition.	Number.
Wisconsin—Continued.	
Pembine, Boulder Creek	1,500
Pemene Creek	2,500
Silver Creek	1,500
Phelps, Muskrat Creek	2,000
Twin Creek	1,500
Plainfield, Ten Mile Creek	3,000
Portage, Prentice Creek	4,800
Wintergreen Creek	4,000
Prentice, Erick Nelson Creek	580
Hanson Creek	580
Hunziker Creek	290
Jump River	580
Maulden Creek	870
Nyeberg Creek	580
Sandeen Creek	580
Welch Creek	580
Rice Lake, Cobb Creek	290
Ridgeway, Strutt Creek	1,600
Williams Creek	1,600
River Falls, Kinnickinnick River, South Fork	580
Sheboygan, Krueger Creek	1,000
Pigeon River and tributaries	4,000
Sheboygan Falls, Mullet River	2,000
Solon Springs, Buckety Creek	†1,000
Sparta, Ash Creek	1,000
Farr Creek	1,000
Ranch Creek	1,000
Squaw Creek	2,000
Spring Brook, Godfrey Creek, West Fork	†1,000
Spring Brook Branch	†1,000
Superior, Big Balsam Creek	†3,000
Empire Creek	†3,000
Tigerton, Tiger Creek	2,000
Tomah, Allen Creek	1,000
Ash Creek	1,000
Bear Creek	1,000
Brandy Creek	1,000
Brush Creek	1,000
Clifton Creek	1,000
Cole Creek	1,000
Council Creek	1,000
Council Creek, South Branch	1,000
Deer Creek	1,000
Dixon Creek	1,000
Jennings Creek	1,000
La Crosse River	1,000
La Fleur Creek	1,000
Mill Creek, North Branch	1,000
Mud Creek	1,000
Prairie Creek	1,000
Prairie Farm Creek	1,000
Sand Creek	1,000
Silver Creek	1,000
Sparta Creek	1,000
Squaw Creek	1,000
Stony Creek	1,000
Swamp Creek	1,000
Tar Creek	1,000
Tomahawk, Beery Creek	500
Big Pine Creek and branch	2,500
Hay Creek	1,000
Little Pine Creek	1,500
Meadow Creek	1,000
Spring Creek	500
Squaw Creek	1,000
Trout Creek	1,500
Trempealeau, Fox Cooley Creek	1,000
French Creek	1,000
Holcomb Cooley Creek	1,000
Norway Cooley Creek	1,000
Pine Creek	1,000
Tamarac Creek	1,000
Tunnel City, Hacket Creek	1,000
Riches Creek	1,000
Sparta Creek, East Branch	1,000
Spring Bank Creek	3,000
Wisconsin—Continued.	
Tunnel City, Stillwell Creek	1,000
Unalaska, Sandy Cooley Creek	†76,000
Warrens, Beltz Creek	1,000
Castle Rock Creek	1,000
Dompky Creek	1,000
Fish Creek	2,000
Lowery Creek	1,000
Mill Creek	2,000
Reed Creek	1,000
Sand Creek	1,000
Second Creek	1,000
Whiskey Creek	1,000
Wyman Creek	2,000
Wascott, Wascott Creek	†3,000
Waukesha, Capt. Lawrence Creek	800
Garrett Creek	800
Genessee Creek	800
Kuhtz Creek	800
Menicks Creek	800
Pazik Creek	800
Rice Creek	2,400
Smith Creek	800
Wagner Creek	800
Wright Creek	800
Waupaca, Dopp Creek	4,000
Emmons Creek	2,000
McLean Creek	2,000
Nicolls Creek	1,000
Pearl Creek	2,000
Pest House Creek	1,000
Radley Creek	3,000
Robinson Creek	1,000
Wausau, Black Creek	2,000
Four Mile Creek	2,000
Freeman Creek	3,000
Gin Moore Creek	2,000
Little Rib River	2,000
Little Trap River	2,000
Pine River	3,000
Pine River, North Branch	2,000
Plover River	11,000
Spring Lake	4,000
Trapp River	5,000
Westby, Carlson Creek	1,000
Dickson Creek	1,000
Eggen Creek	1,000
Hanson Creek	1,000
Holte Creek	1,000
Nelson Creek	1,000
Peterson Creek	1,000
Whitehall, Adams Creek	1,000
Breed Creek	1,000
Caswell Creek	1,000
Cook Creek	1,000
Couron Creek	1,000
Curran Creek	1,000
Farr Creek	1,000
Freeman Creek	1,000
Harlem Creek	1,000
Hamden Creek	1,000
Hensel Creek	1,000
Iduna Creek	1,000
Kidder Creek	1,000
Lake Creek	1,000
Libakken Creek	1,000
McKenzie Creek	1,000
Pike Creek, East Fork	1,000
Solsrud Creek	1,000
Taylor Creek	1,000
Torgerson Creek	1,000
Vold Creek	1,000
Webb Creek	1,000
Wells Creek	1,000
Wood Creek	1,000
Wilton, Dorset Creek	1,000
Gerkes Creek	1,000
McCanns Creek	1,000
Noths Creek	1,000

Total Distribution of Fish and Fish Eggs, by Species, Fiscal Year 1919—Continued.

BROOK TROUT—Continued.

Disposition.	Number.	Disposition.	Number.
Wisconsin—Continued.		Wyoming—Continued.	
Wilton, Sleighton Creek	1,000	Lander, Bear Creek	900
Winneboujou, Bass Lake	†1,500	Bull Lake	1,800
Brule River	†5,000	Crook Creek	900
Cedar Island Lake	†1,500	Deep Creek	900
Cutler Creek	†2,000	Dick Creek	900
Harts Lake	†1,000	Dry Creek	900
Long Lake	†2,000	Dry Creek Lakes	1,800
Loon Lake	†1,500	Dunoir Creek	900
Lucius Lake	†1,500	Farlow Creek	900
Nebagamon River	†2,500	Horse Creek	900
Pierce Lake	†1,500	Jakies Fork Creek	1,800
Winter, Casey Creek	†1,000	Johnson Creek	900
Knapp Stout Creek	†2,000	Little Warm Spring Creek	900
McDonald Creek	†1,000	Little Wind River, forks of	1,800
Phelan Creek	†1,000	Long Creek	900
Spring Creek	†2,000	Lost Lake	900
Wyoming:		McKenney Creek	900
Beulah, Davis Pond	1,500	Meadow Creek	900
Sand Creek	5,400	Rock Creek	900
South Redwater Creek	1,500	Sheep Creek	900
Bonneville, Bonneville Lake	1,800	Sheridan Creek	900
Canyon, Brush Creek	20,000	Simpson Lake	900
Little Rock Creek	20,000	Spring Creek	900
Clearmont, Crazy Woman Creek, North Fork	750	Tory Creek	900
Magdalena Lake	750	Tory Lake	900
Cody, Aldrich Creek	400	Willow Creek	900
Bear Creek	600	Laramie, Brooklyn Lake	20,000
Cabin Creek	1,050	Deep Lake	20,000
Canfield Creek	700	North Gap Lake	17,500
Clearwater Creek	1,750	Towner Lake	17,500
Deer Creek	1,050	Lysite, Railroad Lake	600
Diamond Creek	1,050	Manderson, Medicine Lodge Lake	200
Eagle Creek	1,750	Paint Rock Creek, North Fork	400
Goff Creek	1,050	Solitude Lake	600
Gooseberry Creek	1,750	Newcastle, Cold Creek	4,400
Gunbarrel Creek	1,050	Powell, Blackwater Creek	1,000
Holly Creek	350	Bull Creek	600
Houlihan Creek	350	Ranchester, Prune Creek	450
Jones Creek	600	Wolf Creek	6,000
Little Rocky Creek	1,050	Rock Creek, Rock Creek	300
Mormon Creek	700	Sand Creek, Sand Creek	2,700
Newton Creek	700	Saratoga, Calf Creek	10,000
Paint Creek	700	Cedar Creek	25,000
Pat O'Hara Creek	1,000	Continental Creek	4,000
Rattlesnake Creek	600	Cottonwood Creek	25,000
Rattlesnake Lake	1,000	Jack Creek	51,000
Red Creek	400	Lake Creek	31,000
Snyder Creek	350	Loco Creek	25,000
Trail Creek	400	North Platte River	72,000
Trout Creek	400	Pass Creek	57,000
Twin Creek	400	Rainbow Creek	12,000
Wood River	1,000	Sage Creek	20,000
Yellow Creek	400	Spring Creek, forks of	56,000
Encampment, Beaver Creek	25,000	Sheridan, Kemp Creek	450
Big Creek	25,000	Shoshoni, Gross Creek	900
Cow Creek	35,000	Sundance, Miller Creek	10,000
Encampment River	30,000	Yellowstone, Blacktail Creek	10,500
Salmon Creek	50,000	Glen Creek	10,500
Spring Fork Creek	25,000	Lava Creek	9,000
Grey Bull, Shell Creek	4,900		
Lander, Atlantic Creek	900	Total [a]	* 107,000 † 4,158,050 7,638,615
Baldwin Creek	1,800		

GRAYLING.

Montana: Meadow Creek, Madison River	† 275,000		

[a] Exclusive of 13,800 fry and 11,142 fingerlings lost in transit.

Total Distribution of Fish and Fish Eggs, by Species, Fiscal Year 1919—Continued.

SMELT.

Disposition.	Number.	Disposition.	Number.
Maine:		New York: Tuxedo, applicant	*3,000,000
Holeb, Unknown Pond	†4,000,000		
Otis, Green Lake	†2,437,000	Total	*3,000,000 †6,437,000

PIKE AND PICKEREL.

Arkansas: Black Rock, Black River	*a* 215	Minnesota:	
Illinois:		Homer, Mississippi River	*a* 327,250
Galena, Mississippi River	*a* 115	Red Wing, Mississippi River	*a* 85
Sand Prairie, Mississippi River	*a* 267	Wisconsin:	
Iowa:		Clayton, Mississippi River	*a* 8,700
Bellevue, Mississippi River	*a* 417	La Crosse, Mississippi River	*a* 30,700
Fairport, Mississippi River	*a* 240		
North McGregor, Mississippi River	*a* 3,100	Total	375,935
Pleasant Creek, Mississippi River	*a* 148		
Yellow River, Mississippi River	*a* 4,700		

FRESH-WATER DRUM.

Iowa: Bellevue, Mississippi River	*a* 477
Minnesota: Homer, Mississippi River	*a* 18,500
Total	18,975

CRAPPIE.

Alabama:		Illinois—Continued.	
Alton, Queenstown Lake	60	Coulterville, Adami's Pond	80
Courtland, Big Nance Creek	50	Dallas City, Lake Cooper	*a* 10,775
Arizona: Globe, Roosevelt Lake	900	Freeport, Pecatonica River	2,550
Arkansas: Alma, Big Clear Creek	50	Galena, Mississippi River	*a* 2,173,000
White River, West Fork	50	Marshall, Spring Lake	200
Arkadelphia, Arnold's Pond	22	Meredosia, Illinois River	*a* 33,000
Arnold, Little Red River	400	Naperville, Boecker & von Oven Pond	200
Lost Creek	400	Natural Products Lake	500
Meadow Creek	400	New Boston, Mississippi River	*a* 48,335
Black Rock, Black River	*a* 8,580	Nora, Fevre River	750
Edgemont, Caney Creek	300	Orangeville, Richland Creek	1,050
Red River, Devales Fork	300	Yellow Creek	1,125
Red River, North Fork	400	Quincy, Spring Lake	375
Elba, Hurricane Creek	200	Salem, Salem Pond	80
Linn Creek	300	Sand Prairie, Mississippi River	*a* 1,373,000
Moon Creek	200	Scales Mound, Apple River	1,500
Red River	200	Warren, Apple River	1,500
Everton, Anderson Pond	100	Winslow, Pecatonica River	1,050
Partain, Little Red River	600	Indiana:	
Pine Bluff, Hillcrest Lake	36	Eddy, Long Lake	150
St. Joe, Cave Creek	100	Indianapolis, Sugar Creek	300
Texarkana, Hogane Lake	40	Sellersburg, Belknap Lake	300
Zack, Bear Creek	300	Warsaw, Little Tippecanoe Lake	450
Brush Creek	200	Iowa:	
Colorado:		Earlville, Plum Creek	400
Pueblo, Club Lakes	600	Fairport, Mississippi River	*a* 23,825
Lake Minnequa	200	Lime Springs, Upper Iowa River	900
Connecticut: Hartford, State fish commission	3,600	McDolons Dam, Mississippi River	*a* 40,000
Delaware: Wilmington, Bellvue Pond	1,250	Manchester, Maquoketa River	13,060
Florida: Lake Wales, Starr Lake	330	Mud Hen, Mississippi River	*a* 16,000
Georgia:		North McGregor, Mississippi River	*a* 831,300
Americus, McMath's Pond	21	Pleasant Creek, Mississippi River	*a* 316,250
Muckalee Creek	42	Smiths Ferry, Mississippi River	*a* 467,000
Crawfordville, Cox Lake	3	Waukon, Mississippi River	*a* 8,000
Illinois:		Kansas:	
Anna, Duck Pond	20	Edmond, Gresh's Pond	200
Apple River, Fevre River	750	Edwardsville, Cement Lake	300
Aquauka, Mississippi River	*a* 3,785	Forest Lake	500
Blanding, Mississippi River	*a* 180,000	Holton, Rafter's Pond	400
Cairo, Mississippi River	*a* 159,000	Lenora, Spring Pond	200
Carrollton, Lake of the Woods	60	Parsons, Club Ponds	25
		Pittsburg, Country Club Lake	100

a Rescued from overflowed lands and restored to original waters.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

CRAPPIE—Continued.

Disposition.	Number.
Kentucky:	
East Cairo, Ohio River	a 109,500
Haags Spur, Clear Lake	a 25,000
Prairie Lake	a 6,000
Louisville, Lake Lansdowne	375
Louisiana:	
Homer, Shaw's pond	40
New Iberia, Iberia Lagoon	12
Maryland:	
Baltimore, Gwynn Oak Lake	200
Bethesda, Quarry Pond	375
College Park, Pasture Pond	250
Massachusetts:	
Berkshire, Sandisfield Lake	1,050
Concord, Punkatassett Pond	150
Lowell, Ames's pond	450
Michigan:	
Allenville, Brevort Lake	300
Channing, Sawyer Lake	266
Clyde, Round Lake	300
Crystal Falls, Anderson Lake	100
Fortune Lake	100
Railroad Lake	33
Runkle Lake	33
Stager Lake	34
Upper Holmes Lake	100
Houghton, Fales Lake	100
Weber Lake	200
Iron River, Sunset Lake	100
Jackson, Grass Lake	500
Marquette, Mud Lake	34
Northville, Cooley Lake	300
Twin Lake, Mid Lake	300
North Lake	600
Minnesota:	
Clearbrook, Lindberg Lake	142
Duluth, Lake Antoinette	160
Fairmont, Amber Lake	300
Budd Lake	300
George Lake	300
Hall Lake	300
Sisseton Lake	300
Homer, Mississippi River	a 8,007,225
Mankato, Lake Francis	200
Lake Washington	200
Norwood, Eagle Lake	400
Hyde Lake	400
Red Wing, Mississippi River	a 10,730
Sherburn, Fox Lake	400
Mississippi:	
Ashwood, Thompson's pond	25
Canton, Lake Kirkwood	100
Corinth, Kemper Lake	375
Lake Solitaire	40
Friar Point, Mississippi River	a 23,069
Grenada, Riverdale Pond	50
Oxford, Tarver's pond	150
Woodville, Buckridge Pond	50
Lake Clement	20
Lewis's pond	20
McGehee's pond	20
Sessions's pond	25
Whitstone's pond	50
Missouri:	
Aurora, Flat Creek	600
Carthage, Coolbrook Lake	25
Diamond, Cedar Lake	100
Jonesburg, Ammann Lakes	375
Merwin, Corbin Lakes	350
Monroe City, Hardy's pond	125
Pleasant Hill, Schader's pond	150
Sparta, Finley Creek	200
West Plains, Lake View	400
Montana:	
Glendive, Yellowstone River	750
Miles City, Yellowstone River	750
Nebraska: Rushville, Big Bend Pond	100
New Jersey:	
Butler, Glen Wild Lake	375
Towaco, Surprise Lake	750
New Mexico: Carlsbad, Tansill Lake	100
New York:	
Albany, State fish commission	100
Clemons, Long Pond	150
Fishkill, Bennywater Pond	300
Brinkerhoff Pond	300
Lockport, Red Creek	150
Newburgh, Orange Lake	300
Salisbury Mills Pond	300
Wurtsboro, Masten Lake	150
North Carolina:	
Angier, Spring Branch	200
Battleboro, Davis's pond	200
Bryson City, Tuckaseigee River	400
Burlington, South Piedmont Pond	200
Franklinton, Seven Springs Pond	200
Greensboro, Cool Spring Pond	300
Cunningham Mill Pond	300
Hickory, Cliffs Lake	200
High Point, Furlough Lake	500
Kinston, Jericho Pond	400
Littleton, Warren Pond	500
Marshville, Fairview Pond	100
Pendleton, Stephenson-Skye Mill Pond	400
Raleigh, Lakewood Pond	400
Neuseoco Club Lake	600
Rosindale, Clark Mill Pond	300
Oklahoma:	
Alsuma, Grooshart Pond	100
Antlers, Locke Lake	500
Ardmore, Lake Marie	200
Macks Lake	100
Primrose Lake	400
Carnegie, Stinking Creek	600
McAlester, M. K. & T. Lake	400
Madill, City Lake	300
Frisco Lake	200
Lake Pettijohn	200
Marietta, Harvey Brothers Pond	100
Marietta Club Lake	300
Peak Pond	100
Mill Creek, Blue River	1,000
Pawhuska, Chapman Lake	100
Hatt Lake	100
Perry, Woodruff Lake	400
Rock Island, James Lake	100
Spiro, Bowman's pond	100
Stillwater, Lowery's pond	300
Tulsa, Tribes Lake	400
Wewoka, George Cooper Pond	300
Wister, Clear Lake	300
Pennsylvania:	
Canton, Towanda Creek	225
Moscow, Foundry Pond	150
Krotser Pond	150
Mud Pond	150
South Carolina:	
Batesburg, Strother Pond	400
Greenville, Southern Power Pond	400
Leesville, Shealy Pond	300
Orangeburg, Edisto River	300
Seneca, Miller's pond	100
South Dakota:	
Milbank, Big Stone Lake	500
Tyndale, Merkel Lake	800
Tennessee:	
Covington, Sheltondale Pond	250
Franklin, West Harpeth River, Murphy Fork	45
Memphis, Stephenson Pond	20
Nashville, Lake Kewalco	261
Texas:	
Belcherville, Belcherville Lake	1,300

a Rescued from overflowed lands and restored to original waters.

Total Distribution of Fish and Fish Eggs, by Species, Fiscal Year 1919—Continued.

CRAPPIE—Continued.

Disposition.	Number.	Disposition.	Number.
Texas—Continued.		Wisconsin—Continued.	
Brenham, Club Lake	140	Lake Millicent, Lost Lake	71
Lake Henry	70	Rocky Lake	71
Burton, Watson's pond	70	Lavalle, Cazenovia Mill Pond	400
Virginia:		Lynxville, Mississippi River	[a] 8,000
Beaver Dam, Beaver Dam Pond	200	Manson, Manson Lake	160
Cohoke, Mill Creek Pond	300	Mason, Bass Lake	250
Crewe, Crystal Lake	300	Mercer, Trude Lake	1,000
Disputanta, Disputanta Pond	400	New Auburn, Axe Handle Lake	350
Emporia, Jones Pond	400	Silver Lake	300
Gretna, Fitzgerald's mill pond	250	New Richmond, Cedar Lake	200
Hanover, Lake Aylett	400	Little Round Lake	200
Hewlett, Mount Ida Pond	100	Lower Pine Lake	200
Ivanhoe, Mill Creek	625	Middle Pine Lake	200
Painter Creek	625	Upper Pine Lake	200
Kinsale Wharf, School Pond	100	Norrie, Kelleys Pond	200
Richmond, Jollys Mill Pond	200	Lake Go To It	200
Lakeside Lake	300	Lake Wausau	200
Suburban Lake	300	Lone Rice Lake	200
Stony Creek, Sapponey Creek	400	Mayflower Lake	200
Suffolk, Lake Savage	400	Mud Lake	200
Sweet Hall, Custis Lake	100	Plowman Lake	200
Wytheville, Reed Creek, North		Road Lake	200
Fork	500	Smith Lake	200
Zuni, Darden Lake	400	Stony Lake	200
Niblett Mill Pond	400	Osseo, Osseo Mill Pond	500
Wisconsin:		Prairie du Chien, Mississippi River	[a] 199,300
Athens, Black Creek	300	Reedsburg, Bay View Pond	300
Blair, Trempealeau River	1,000	Gray Pond	500
Trempealeau River Pond	2,000	Lawton's pond	500
Boyd, Pike Lake	300	Osborne's pond	400
Yellow River	260	Richfield, Friess Lake	200
Centuria, Deer Lake	500	Solon Springs, Beauregard Lake	80
Chippewa Falls, Glenn Loche Pond	300	Somerset, Bass Lake	300
Walters Pond	300	Superior, Amnico Lake	160
Clayton, Mississippi River	[a] 126,000	Lyman Lake	80
Frenchtown, Mississippi River	[a] 8,000	Tomah, Water Mill Pond	300
Gordon, Snider Lake	80	Tomahawk, Beaver Lake	150
Hayward, Calhoun Lake	200	Lake Mabel	150
Charlie Lake	200	Lily Lake	150
Hallie Lake	200	Mirror Lake	150
Harriett Lake	200	Somo Lake	150
Horse Lake	200	Twin Lakes	150
Rice Lake	200	Eyalusing, Mississippi River	[a] 10,000
La Crosse, Mississippi River	[a] 1,507,800	Mexico: Nacozari, Huacal Dam	5,000
Lake Millicent, Five Island Lake	71		
Lake Millicent	71	Total [b]	15,837,865

LARGEMOUTH BLACK BASS.

Alabama:		Alabama—Continued.	
Alexander City, Foshee Mill Pond		Florence, Little Cypress Creek	†6,000
Creek	†2,000	Sweetwater Creek	†3,000
Hillabee Creek	†4,000	Gantt, Huckaba's pond	3,000
Sunny Leve' Creek	†2,000	Gantts Junction, Gantts Quarry	
Tallapoosa River	†3,000	Lake	†3,000
Anniston, Blue Pond	†2,000	Geiger, Liars Club Lake	†3,000
Hughes Mill Pond	†2,000		450
Rock Creek	†3,000	Gordo, Kirk's pond	200
Ashland, Jefferson Lake	†2,000	Grand Bay, Jackson Creek	†4,500
Atmore, Hurricane Pond	250	Greensboro, Millwood Pond	900
Bayou la Batre, Bayou la Batre	†9,000	Greenville, Sirmon's pond	†2,000
	1,950	Grimes, Edwards's pond	†1,000
Carl Creek	†2,000	Haleyville, Horseshoe Lake	630
Brierfield, Mahan Creek	†6,000	Wilson Lake	200
Calvert, Tombigbee River	1,225	Hartselle, Big Spring Lake	†3,000
Decatur, Beaver Lake	2,000	Hough Creek Pond	†3,000
Delchamps, East Fowl River,		Heflin, Snake Creek	†2,000
branches of	†13,500	Huntsville, Braham Spring Pond	225
Epes, Manicce Lake	1,000	Kushla, Chickasawbogue Creek	†11,000
Monette Pond	1,500	Lineville, Smith's lake	1,000
Fayetteville, Cedar Creek	4,000	Loxley, Fish River	†6,000
Pennywinkle Creek	3,000	McElderry, Cheaha Creek	†3,000
Florala, Lake Jackson	2,100	Madison, Bradley Pond	†4,500
Miller Pond	700	Bronaugh Pond	†4,500

[a] Rescued from overflowed lands and restored to original waters.
[b] Exclusive of 2,462 fingerlings lost in transit.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

LARGEMOUTH BLACK BASS—Continued.

Disposition.	Number.	Disposition.	Number.
Alabama—Continued.		Arkansas—Continued.	
Madison, Burnam Lake	†6,000	El Dorado, Dumas Pond	600
Clay Pond	†7,500	Sloan's lake	1,500
Gum Pond	†3,000	Fayetteville, Davidson Lake	100
Lanier's pond	†7,500	Gurdon, Rawl's pond	300
Willow Pond	†4,500	Hardy, Spring River	400
Maide Marion, Moore's lake	675	Harrison, Huzzah Creek	1,200
Mobile, Bayou Sara	†3,000	Hermitage, Ferguson's pond	400
Big Creek	2,050	Hope, Allen's pond	300
Crichton Pond	1,000	Coffey Lake	900
Deer River	†3,000	Little Rock, Spring Lake	600
	1,050	Luna, Lake Chicot	1,000
Hall Mill Creek	†4,000	Mammoth Spring, Tracey Creek	200
Little Creek	2,000	Monticello, Wood's lake	800
Miller Creek	†4,000	Morrillton, Morrillton Lake	400
Nigger Lake	1,000	Oil Mill Pond	300
Shell Bayou	1,050	Nashville, Orchard View Pond	1,500
Montgomery, Cain's pond	†2,000	Paragould, Hill Lake	600
Crescent Lake	4,000	Readland, Grand Lake	2,000
Jordan's pond	2,000	Rosboro, Lumber Company Pond	600
Mountain Creek, Faulkner Pond	2,000	Russellville, Big Piney River	600
Taber Pond	3,000	Illinois River	600
Mount Vernon, Cedar Creek	1,500	Illinois River, North Fork	600
Mill Creek	1,500	Springdale, Lower White River	300
Oneonta, Warrior River and branches	3,375	South Osage River	300
		Walker Lake	200
Perdido Station, Johnson's pond	100	West Brush Creek	200
Pine Hill, Sheffield's ponds	800	Warren, Lucas's pond	400
Pleasant Gap, Hurricane Creek	†3,000	Salina River	500
Ramer, Bermuda Lake	†2,000	Womble, Ouachita River, South Fork	600
Riderwood, Lake Choclahana	150		
Rusellville, Lake Galey	†2,000	Colorado:	
	630	Colorado Springs, Douglas Lakes	500
Sellers, Findley's pond	†2,000	Craig, Yumpa River	500
Sheffield, Lake Wilson	1,500	Greeley, Timnath Lake	500
Speigner, Speigner Lake	4,000	Paonia, Winter's pond	120
Sterrett, Bear Creek	2,000	Pueblo, Club Lakes	2,100
Kelley Creek	4,000	Tabernash, Thompson's pond	400
Sulligent, Northington's pond	240	Connecticut:	
Talladega, Cheaha Creek	2,000	Jewett City, Ashland Pond	400
Choccolocco Creek	4,000	Rockville, Crystal Lake	300
Pope Creek	1,000	Snipsic Lake	300
Roberson Mill Pond	2,000	Wallingford, Quonnipaug Lake	400
Rock Spring Lake	3,000	Delaware:	
Silver Lake	3,000	Delaware City, St. Georges Creek	225
Town Creek, Town Creek	1,125	Felton, McCauley Mill Pond	150
Dinkins's pond	3,000	Frankford, Derickson Creek	200
Northcutt's pond	1,350	Laurel, Trussom Pond	200
Silver Lake	3,350	Wilmington, Hockessin Pond	150
Tyler, Quarles's pond	1,000	Florida:	
Wagar, McClure Mill Pond	2,000	DeFuniak Springs, Buffalo Lake	1,400
Walker Springs, Mason Mill Pond	1,650	Chipley Park Lake	7,400
Winfield, Indian Creek	200	Lily Pad Lake	1,750
Yellow Pine, Dog River	1,500	Ehren, Lily Pond	700
Arizona:		Fruitland Park, Crystal Lake	700
Flagstaff, Mormon Lake	240	Lake Myrtle	700
Oak Creek	240	Gainesville, Cashalton Lake	700
Globe, Pinal Creek	200	Hague, Layne's pond	350
Roosevelt Lake	5,600	Kissimmee, Lake Tohopekaliga	2,100
Holbrook, Becker Lake	80	Lady Lake, Lake Dream	700
Humboldt, Hooker Lake	160	Lake Hermosa	700
Lukachukai, Lukachukai Lake	80	Park Lake	700
Tempe, Tempe Drainage Canal	200	Sunset Lake	350
Williams, Cataract Ponds	320	Mohawk, Mohawk Lake	1,050
Winkelman, Meyer's pond	100	Olive, Olive Pond	700
Arkansas:		Pomona, Lake Broward	1,750
Alpena, Long Creek	1,600	Quincy, Dixie Pond	700
Arkadelphia, Caddo Creek	1,200	St. Petersburg, Lake Maggorie	1,400
Atkins, Illinois Bayou	600	Stella, Turner's pond	1,050
Batesville, Blue Creek	600	Walden Spring Branch	700
Ruddell Lake	600	Tallahassee, Wards Mill Pond	1,400
Berryville, Kings River	1,600	Tampa, Mango Lake	1,400
Black Rock, Black River	a 725	Windemere, Lake Butler	1,400
Canway, Golds Lake	400	Lake Tobet	1,400
Owen Lake	1,000	Georgia:	
Corning, Black River	800	Albany, Kinchafoonee Creek	†5,000
Corning Lake	800	Muckalee Creek	†5,000
Cotter, White River	†2,000	Americus, Muckaloochee Creek	†5,000
	800	Ashburn, Tharpe's pond	350

a Rescued from overflowed lands and restored to original waters.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

LARGEMOUTH BLACK BASS—Continued.

Disposition.	Number.	Disposition.	Number.
Georgia—Continued.		Illinois—Continued.	
Atlanta, East Lake	6,000	Nora, Fevre River	200
Augusta, Carmichael Pond	4,000	Sand Prairie, Mississippi River	a 20,200
Old Brad Merry Mill Pond	3,000	Sciota, Yellow Creek	160
Bainbridge, Lake Carlford	700	Shawneetown, Wimbo Lake	200
Lake Douglas	1,050	Warren, Fevre River	600
Boston, McRae Lake	700	Indiana:	
Bowman, Campbell Mill Pond	2,000	Albion, Neufer's pond	225
Box Springs, Lake Mohigniac	† 3,000	Angola, Crooked Lake	375
Byron, Crawford Lake	3,000	Bluffton, Old Erie Stone Quarry Pond	200
Canton, Johnson's pond	1,000	Wabash River	500
Cartersville, Euharlee Creek	1,250	Bremen, Lake of the Woods	375
Chula, Cypress Pond	1,400	Corydon, Elm Lake	80
Clarkston, Sam's pond	1,000	Corydon Junction, Buck Creek	240
Comer, Gholston's pond	2,000	Hartman's pond	80
Crawfordville, Little River, North Prong	2,000	Quebbeman Lake	80
Douglas, Vickers's pond	1,050	Culver, Lake Maxinkuckee	1,200
Fairfax, Satilla River	1,400	Eddy, Atwood Lake	300
Griffin, Lake Rushton	† 2,000	Hackenburg Lake	300
Kibbee, Black Pond	3,000	Meesic Lake	300
Kite, Meeks's pond	1,000	Whitmer Lake	400
La Grange, Lazylands Lake	3,000	Elkhart, Boston Lake	500
Leary, Daniel's pond	700	Hillsboro, Coal Creek	60
Lithonia, Watson's pond	2,000	Hobbs, Carr's pond	70
Lumpkin, Deason Lake	† 2,000	Huntingburg, Ferdinand Lake	120
Geeslin Pond	† 2,000	Indianapolis, Little Eagle Creek	125
Ray Pond	† 2,000	White River	175
Macon, Halcyon Lake	† 4,000	Kendallville, Long Lake	400
Nelson Mill Pond	† 3,000	Logansport, Binns's pond	60
Riggins Mill Pond	† 3,000	Brandt's pond	90
Willow Lake	† 3,000	Pipe Creek	150
Marietta, Golf Club Lake	1,500	Lynn, Clark's pond	200
Marshallville, Haslam's pond	4,000	Michigan City, Tee Lake	450
Millen, Buckhead Creek	3,000	Mill Creek, Fish Lake	575
Millhaven, Brier Creek	4,900	Muncie, South Lagoon	300
Montezuma, Lewis Mill Pond	4,000	New Albany, Indian Creek	240
Mount Vernon, Palmer's pond	3,000	Oak Knoll Pond	80
Newman, Wynn's pond	† 3,000	Paoli, Lick Creek	150
Nunez, Ohoopee River	6,000	Log Creek	60
Oglethorpe, English Pond	3,000	Pierceton, Webster Lake	160
Poulan, Chapman's pond	350	Pittsboro, White Lick Creek, Middle Fork	80
Clements's pond	700	Ramsey, Crystal Pond	80
Raymond, Raymond Lake	† 4,000	Rochester, Dudgeon's pond	400
Rome, Dykes Creek	1,500	Shelbyville, Flat Rock River	240
Dykes Creek, West Fork	1,500	Terre Haute, Greenfield Bayou	180
Sharpsburg, Pitman's pond	† 1,000	Valparaiso, Wahob Lake	220
Soperton, Henry's pond	2,000	Veedersburg, Coal Creek	100
Stillmore, Durden's pond	2,000	Warsaw, Tippecanoe Lake	200
The Rock, Stafford's pond	† 3,000	White Pigeon, Stone Lake	300
Valdosta, Lake Spurlin	700	Wilkinson, Perry Lake	40
Woodland, Flint River	4,000	Iowa:	
Illinois:		Bellevue, Mississippi River	a 715
Alpha, Crescent Lake	210	Creston, Summit Lake	420
Antioch, Huntley Lake	160	Earlville, Plum Creek	150
Apple River, Fevre River	200	Fairport, Mississippi River	a 5,516
Aquaka, Mississippi River	a 195	Harpers Ferry, Mississippi River	a 2,625
Blanding, Mississippi River	a 2,300	Le Mars, Dalton Pond	100
Brighton, Stubblefield's pond	100	Lime Springs, Upper Iowa River	5,400
Carrollton, Walnut Lake	250	Manchester, Maquoketa River	400
Colfax, Gillam's pond	50	Mason City, Lime Creek	150
Coulterville, Illinois Central Lake	250	North McGregor, Mississippi River	a 1,300
Council Hill, Fevre River	200	Ottumwa, Loch Burns Pond	270
Dallas City, Lake Cooper	a 820	Pleasant Creek, Mississippi River	a 2,350
Decatur, Club Lake	575	Smiths Ferry, Mississippi River	a 950
Freeport, Richland Creek	80	Kansas:	
Galena, Mississippi River	a 7,297	Caney, Havana Country Club Lake	400
Grayslake, Huntley Lake	160	Chanute, Shadow Lawn Pond	300
Hudgens, Hudgens Lake	250	Kincaid, Grindstone Lake	225
McConnell, Pecatonica River	40	Silver Spring Lake	225
Meredosia, Illinois River	a 6,000	Olathe, Twin Lakes	300
Moline, Lake Ivo	90	Parsons, Club Ponds	25
Naperville, Du Page River	220	Pittsburg, Country Club Lake	400
Natural Products Lake	150	Quinter, Saline River	500
New Boston, Mississippi River	a 2,660		

a Rescued from overflowed lands and restored to original waters.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

LARGEMOUTH BLACK BASS—Continued.

Disposition.	Number.
Kentucky:	
Baskett, Baskett Lake	150
Bowling Green, Morris's pond	90
Bristow, Gott's pond	160
Hays's pond	240
Campbellsville, Pitman Creek	320
Cave City, Ford's pond	160
Covington, Michels Pond	160
Crab Orchard, Clearwater Lake	70
Daniel Boone, Boone Lake	60
East Cairo, Ohio River	[a] 100
Edgoten, Ingleside Lake	250
Eminence, Sanford's pond	70
Eubank, Caney Creek	160
Fulton, Fall's pond	150
Guthrie, Meadow Grove Pond	150
Spring Creek	150
Herndon, Smith's pond	200
Hodgenville, Beams's pond	80
Nolin River, South Fork	240
Horse Cave, Taylor's pond	80
Vancleve's pond	80
Louisville, Douglas Park Lake	105
Lake Lansdowne	70
Morganfield, Robertson Pond	60
Mt. Sterling, Karrick's pond	80
Munfordville, Wood's pond	450
Petroleum, Big Trammell Creek	300
Richmond, Lake Reba	240
Shelbyville, Bullskin Creek	105
Clear Creek	105
Somerset, Meece's pond	80
South Park, South Park Lake	700
Trenton, Chiles Pond	200
Crutchfield's pond	200
Mc Elwain's pond	200
Maplewood Pond	200
Riley's pond	200
Wright's pond	200
Pine Grove, Weymeth Lake	120
Louisiana:	
Ashland, Drigger's pond	†2,000
Abbeville, Vermillion River	1,250
Eunice, Gourney Lake	†7,000
Goldoma, Harlan's pond	†3,000
Iota, Hayes Lake	†5,000
Lejeune Pond	1,250
LaFayette, Francez's pond	1,800
Lake Charles, Perkins's pond	1,250
Mansfield, Wemple's pond	24
Peason, Peavy Wilson Lake	†3,000
Urania, Lake Urania	†4,000
Wisner, Pennebaker's pond	140
Maryland:	
Antietam, Potomac River	400
Baltimore, Gwynn Oak Lake	60
Lake Kukhills	120
Cambridge, Blackwater River	150
Chicacomico River	150
Transquaking River	150
Catoctin, Potomac River	100
Cumberland, Potomac River	490
Potomac River, North Branch	650
East New Market, Smith's pond	150
Geices, Youghiogheny River	400
Glendale, Folly Run	400
Hyattsville, School House Pond	180
Lansdowne, Lugenbeel's pond	200
Linkwood, Higgins Mill Pond	150
Popes Creek, Power House Pond	400
Queen Anne, Moores Mill Pond	200
Robinson, Magothy River	300
Taneytown, Big Pipe Creek	200
Timonium, Spring Run	400
Trappe, Wrights Mill Pond	200
Worton, Montabello Lake	200
Massachusetts:	
Edgartown, Edgartown Great Pond	500
Lowell, Concord River	65
Flushing Pond	130
Hart Pond	130
Merrimac River	130
Nabnassett Pond	130
Newfield Pond	130
Tyngs Pond	130
Michigan:	
Baraga, Springwater Lake	200
Bergland, Lake Gogebic	300
Brighton, Woodruff Lake	225
Bruce Crossing, Spring Lake	200
Calumet, Rice Lake	200
Caspian, Chicagoan Lake	150
Champion, Fish Lake	200
Lake Michigamme	300
Comins, Pond Lake	300
Crystal Falls, Fortune Lake	100
Holmes Lake	100
Lower Holmes Lake	100
Paint River	100
Railroad Lake	100
Silver Lake	100
Swan Lake	100
Tobin Lake	100
Dunham, Lake Celeste	200
East Tawas, Sand Lake	375
Gwinn, Bass Lake	100
Houghton, Elm River Lake	200
Lake Eva	300
Lake Gerald	200
Snake River	200
Iron Mountain, Powder Lake	200
Iron River, Iron Lake	150
Morrison Lake	75
Round Lake	150
Keweenaw Bay, Mud Lake	200
Lake Rowland, Lake Rowland	200
Little Lake, Little Lake	300
Low Moor, Forbs Lake	100
Horseshoe Lake	200
Klippells Lake	100
Lake Lowery	200
Palmer Lake	100
Wolf Lake	100
Marquette, Lake Van Iderstine	500
Mass, Courtney Lake	200
Michigamme, Gibson Lake	200
Lake Michigamme	300
Munising, Annie River	800
Negaunee, Horseshoe Lake	100
Perch Lake	100
Teal Lake	100
Painesdale, Stonington Lake	200
Pentoga, Chicagoan Lake	200
Indian Lake	300
Republic, Allens Lake	100
K. C. Lake	100
Laxstrom Lake	100
Michigamme River	100
Porterfield Lake	200
Spruce Creek	100
Romeo, Cusic Lake	450
Rose Center, Munger Lake	150
Rose City, Wagner Lake	300
Sand River, Lake Lillie	200
South Range, Otter Lake	200
Stager, Little Tobin Lake	200
Round Lake	100
Stager Lake	200
State Line, Moon Lake	100
Toivala, Lake Eva	200
Trout Lake, Carp Lake	200
Watersmeet, Lake Cisco	1,100

[a] Rescued from overflowed lands and restored to original waters.

Total Distribution of Fish and Fish Eggs, by Species, Fiscal Year 1919—Continued.

LARGEMOUTH BLACK BASS—Continued.

Disposition.	Number.
Michigan—Continued.	
Wellsburg, Avery Lake	200
Soldiers Lake	200
Minnesota:	
Barnesville, Nyeng Lake	300
Solum Lake	400
Bernum, Big Lake	100
Hanging Horn Lake	100
Biwabik, Bass Lake	400
Carlton, Chub Lake	100
Chatfield, Root River, North Branch	750
Chaska, Pierson Lake	115
Chisholm, Dewey Lake	400
Perch Lake	300
Sturgeon Lake	300
Clearbrook, Johnson Lake	80
Cokato, Skipstrom Lake	500
Cologne, Miller Lake	390
Cottonwood, Cottonwood Lake	140
Duluth, Deep Water Lake	80
Little Beaver Creek, branch of	100
Pike Lake	80
Fairmont, Amber Lake	300
Budd Lake	300
Clear Lake	300
George Lake	300
Hall Lake	300
Sisseton Lake	300
Wilmert Lake	300
Fergus Falls, Forfoot Lake	400
Wenstrom Lake	300
Gilbert, Cedar Island Lake	300
Hackensack, Little Whitefish Lake	902
Herman, Bernice Lake	300
Holdingford, Lake Marie	120
Homer, Mississippi River	[a] 92,120
Knife River, Harriet Lake	150
Tettegouche Lake	150
Le Roy, Upper Iowa River	150
Lindstrom, Little Lake	500
Mankato, Lake Francis	750
Lake Washington	750
Mazeppa, Mazeppa Power Lake	535
Rochester Power Lake	535
Zumbro River	625
Zumbro River, North Branch	535
Miroc, Riley Lake	500
Morris, Crooked Lake	225
Pine River, Crooked Lake	125
Red Wing, Mississippi River	[a] 430
Rochester, Zumbro Lake	440
Zumbro River	440
Rosemount, Lake George	313
Rutledge, Long Lake	100
St. Cloud, Block Lake	125
St. Paul, Mississippi River	400
State fish commission	6,500
Sherburn, Fox Lake	300
Tamarack, Round Lake	80
Trail, Halverson Lake	120
Victoria, Auburn Lake	120
Winona, Lake Winona	22
Wright, Ox Eye Lake	80
Mississippi:	
Aberdeen, Burk Gallop Pond	675
Jones Lake	†3,000
Jones's pond	†3,000
Smith's lake	†3,000
Armory, Gallop's pond	450
Bay Springs, Yelverton's pond	†1,000
Blue Springs, Hall's pond	500
Canton, Big Lake	705
Blackton's pond	†6,000
Carba[illegible]o's pond	†6,000
Cedar Bluff, Cottonwood Pond	600
Chunky, Moore's pond	450
Collins, Beauty Pond	†3,000
McQueene's pond	†3,000
Mississippi—Continued.	
Columbus, Byler Lake	†3,000
Harvey Lake	†3,000
Corinth, East Lake	450
Hinton Lake	†4,500
Lamberth's pond	†3,000
Cotton Plant, Guyton's pond	†2,000
Crystal Springs, Goodwin's pond	675
D'Lo, Finkbine Log Pond	375
Fayette, Carother's pond	250
Friar Point, Mississippi River	[a] 22,005
Moon Lake	500
Fulcher, Snow's pond	200
Guntown, Gum Pond	†3,000
Hattiesburg, Ogden Mill Pond	600
Hazlehurst, Lake Hazle	625
Helm, Helm's pond	250
High Point, Dempsey's pond	†2,000
Hillsdale, Batson's pond	1,950
Holly Springs, Dunlap-Williams Ponds	1,500
Jackson, Croom Pond	250
Gary's pond	450
Hall's pond	900
Ratliff's pond	200
Kosciusko, Bailey Lake	705
Eastman-Gardiner Pond	†4,000
Long Pond	470
Louisville, Fulton Pond	400
Louisville Club Lake	800
McCool, Smith Spring Pond	705
Macon, Club Lake	†7,000
Gurler's pond	†1,600
Thompson's pond	†3,000
Magnolia, Minnehaha Creek	†3,000
Tangipahoa River	†7,500
Meridian, Waterworks Lake	450
Mobile, Franklin Creek	†4,000
Natchez, Sligo Pond	400
Springfield Pond	200
New Albany, Bias's pond	1,000
Branyan's pond	500
Fife's pond	†2,000
Hall's pond	600
Parker's pond	115
Potts Pond	†2,000
Robbins's pond (A)	400
Robbins's pond (B)	600
Robbins's pond (C)	800
Pachuta, Ohalti Lake	†9,000
Pecan, Franklin Creek	†3,000
Goode Mill Lake	†5,000
Pelahatchee, Clear Branch Pond	†1,600
Pheba, Bridges Mill Pond	1,000
Lee's pond	500
Loyd Pond	400
Old Rife Pond	1,000
Picayune, East Hobolochitto Creek	†6,000
Tate's lake	†2,000
Plantersville, Park Lake	100
Red Oak Lake	450
Pontotoc, Ferguson's pond	675
Highland Pond	200
Mable Lake	450
Moss Pond	†2,000
Orchard Lake	675
Ridgeway Lake	†2,000
	450
Port Gibson, Gage Pond	400
Woodburn Lake	400
Richton, Smith's pond	†2,000
Saucier, Hester Creek	1,200
Scooba, Trammell's pond	200
Scott, Lake Bolivar	450
Starkville, Pearsons Caldwell Pond	200
Stephenson, Foster Creek Mill Pond	625
Sturgis, Daniel Lake	†3,000
Parker Slough	†7,500

[a] Rescued from overflowed lands and restored to original waters.

Total Distribution of Fish and Fish Eggs, by Species, Fiscal Year 1919—Continued.

LARGEMOUTH BLACK BASS—Continued.

Disposition.	Number.
Mississippi—Continued.	
Sumner, Stephen's pond	750
Tibbee Station, Scuppermong Farm Pond	800
Utica, Oak Grove Lake	400
Wortham, Lee's pond	200
Missouri:	
Brashear, Quinn's pond	90
Cabool, Arthur Creek	90
Big Creek	90
Brushy Creek	90
Elk Creek	90
Little Indian Creek	175
Little Piney Creek	90
Carthage, Coolbrook Lake	25
Cedar Gap, Cedar Gap Lake	120
Deepwater, Club Lake	300
Houston, Big Piney River	200
Indian Creek	50
Joplin, Arrowhead Lake	2,000
Moore's pond	25
Thomas Lakes	100
Kansas City, Fairmont Lake	500
Lebanon, Ballinger Pond	400
Liberty, Urban Lake	400
Little Blue, Dierks Lake	300
Merwin, Corbin Lake	600
Neosho, Hickory Creek	112
Nevada, Radio Springs Lakes	500
Oasis, Fish Lake	150
Phillips, McMenus's pond	100
Pleasant Hill, Baldwin Lake	200
Rolla, Little Piney River	300
Saginaw, Walker Lake	50
Springfield, Kunzman's pond	50
West Plains, Lake View	50
Montana:	
Glendive, Yellowstone River	245
Miles City, Yellowstone River	455
Nebraska:	
Glan, Meadow Brook Lake	300
Rushville, Davis's pond	200
Nevada: Fallon, Cottonwood Canon Run	150
New Hampshire:	
Newport, Crystal Lake	150
Ledge Pond	150
Rockybound Pond	150
New Jersey:	
Asbury Park, Kisner Mill Pond	200
Butler, Butler Lake	80
Cold Spring Lake	80
Echo Lake	80
Kampfe Lake	150
Mud Pond	80
Wittack Lake	80
Cedar Crest, Cedar Crest Lake	200
Chatsworth, Cranberry Lake	200
Elberon, Poplar Brook Lake	200
Gibbstown, Repaupa Creek	225
Towaco, Surprise Lake	300
New Mexico:	
Aztec, Animas River	120
Carlsbad, Black River	200
Pecos River	200
Tansill Lake	200
Colmar, Valdez Lake	80
Cutter, Elephant Butte Lake	240
Lake B. M. Hall	240
Gallup, Ramah Lake	160
Las Vegas, Horse Lake	16
Laguna Secunda	60
LaQuesa Grande Lake	16
Little Lake	16
Organ Lake	160
Pecos Bridge Lake	80
Round Lake	16
Magdalena, V. T. Lake	100
Monero, Horse Lake	300
Nara, Curio Lake	100
New Mexico—Continued.	
Onava, Five Lakes	160
Raton, Barilla Mesa Lake	80
Brannan Lake	40
Davis Lake	40
Eagle Nest Lake	40
Roswell, Penasco River	200
Round Lake	200
Santa Rosa, Storage Lake	300
Springer, Reservoir No. 2	320
New York:	
Albany, Nassau Lake	600
Binghampton, Susquehanna River	500
Cattaraugus, Clear Pond	100
Corinth, Efner Lake	150
Cornwall, Popolo Lake	300
Davenport Center, Sherman Lake	200
Elmira, Chemung River	500
Hamilton, Woodman Pond	400
Lyons, Canandaigua Creek	300
Canargua Creek	300
Montour Falls, Catherine Creek	300
Mount Kisco, Wood's pond	200
Mount Vision, Gregory's pond	100
Newark, Canandaigua Creek	300
Coffey Lake	300
North Carolina:	
Aberdeen, Marie Pond	2,000
Sand Hill Lake	3,000
Ashboro, City Pond	400
Bayboro, Bay River	†400
Bostic, Rocky Broad River	450
Burlington, Dickey's pond	1,500
Sartin Mill Pond	1,500
Old Willow Brook Pond	1,500
Silver Lake	1,500
Stinking Quarter Pond	1,400
Walkers Pond	1,400
Calypso, Sutton's pond	200
Cary, Holleman's pond	200
Charlotte, Catawba River	1,750
Clinton, Great Coharie Creek	120
Six Runs	120
Corinth, Yarborough's pond	†400
Dunn, Jernigan's pond	400
Smith Mill Pond	600
Durham, Angier Pond	300
Caroenter Pond	275
Wilbon Pond	300
Elkin, Carter Falls Pond	200
Elkin River	225
Ellerbe, Howell's pond	2,000
Quick's pond	2,000
Fayetteville, Morrison's pond	400
Flat Rock, King's pond	2,000
Ottaray Lake	3,000
Smythe's pond	4,000
Graham, Pine Hill Pond	600
Thompson Pond	100
Greensboro, Revolution Pond	3,300
Seminole Pond	4,100
Havelock, East Creek	1,350
Hendersonville, Bane's pond	100
Few's pond	300
Hayne's pond	500
Maybank's pond	300
Scheppergrell's pond	300
Vincent's ponds	300
Hickory, Catawba River, Henrys Fork	100
Catawba River, Jacobs Fork	100
High Point, Walnut Branch Pond	600
Kinston, Jericho Pond	400
Knightdale, Mill Pond	400
Lenoir, Buffalo Creek	100
Marble, Hyatts Creek	3,000
Valley River	3,000
Marion, Big Buck Creek	100
Brown Mill Pond	100
Catawba River	100

Total Distribution of Fish and Fish Eggs, by Species, Fiscal Year 1919—Continued.

LARGEMOUTH BLACK BASS—Continued.

Disposition.	Number.
North Carolina—Continued.	
Marion, Little Buck Creek	100
Lofte Mill Pond	100
Morgan's pond	100
Marshville, Austin's pond	700
Lanes Creek	450
Simpson's pond	1,400
Mount Airy, Minnick's pond	3,400
New Bern, Brices Creek	900
Neuse River	1,100
Trent River	1,100
Newport, Lake Oxley	† 200
Newton, Pinchgut Creek Pond	200
Norlina, Watson's pond	200
Princeton, Holt's pond	600
Raeford, Beaverdam Pond	400
Raleigh, Boone's pond	400
Doctors Lake (A)	400
Doctors Lake (B)	400
Neuseoco Club Lake	600
Randleman, Bullrun Pond	200
Richfield, Morgan's pond	100
Salisbury, Graf's pond	100
Samarcand, Drowning Creek	4,000
Lake Tamarlane	2,000
Shulls Mills, Watauga River	1,700
Smithfield, Holts Lake	1,300
Stokesdale, Enoch's pond	300
Sylvia, Cullowhee Creek	2,000
Scott Creek	2,000
Tuckaseigee River	5,000
Tuckaseigee River, Left Fork	3,000
Tuckaseigee River, Right Fork	3,000
Tarboro, Fishing Creek	400
Lake Parks	400
Tar River	400
Warren Plains, Dillard's pond	† 200
Tharrington's pond	† 200
Washington, Broad Creek	600
Chocowinity Bay	600
Chocowinity Creek	600
Respess Mill Pond	600
Upper Broad Creek	600
Winston-Salem, Ariston Pond	2,800
Woodside, Lake Lilly	† 200
Youngsville, Moores Pond	† 400
North Dakota:	
Dazey, Ensign Lake	120
Douglas, Nelson-Darlson Lake	160
Tangedahl Lake	120
Forman, Lake Tjor	160
Lake Williams, Lake Williams	160
Mercer, Brush Lake	240
Petrel, City Lake	72
Spring Lake	90
Valley City, Moon Lake	240
Winner, Dog Ear Lake	125
Ohio:	
Akron, East Lake	150
Long Lake	150
Nesmith Lake	150
Rex Lake	150
West Lake	150
Alliance, Westville Lake	375
Antwerp, Maumee River	500
Bedford, Tinkers Creek	150
Berea, Diamond Lake	500
Lake Abram	500
Riddle's pond	625
Ruky Lake	625
Berlin Center, Spring Lake	1,500
Blanchard, Gardner Quarry Pond	200
Cambridge, Brush Fork Creek	625
Chillicothe, Lake Rowena	250
Paint Creek	875
Cleveland, Shaker Heights Lake	225
Columbus, Rocky Fork Creek	625
Crestline, Sandusky River	300
Walker Lake	225
East Monroe, Lees Creek	300
Ohio—Continued.	
Fostoria, Lake Adams	300
Galion, Sandusky River	625
Geneva, Grand River	225
Greenfield, Buckskin Creek	300
Paint Creek	1,200
Rattlesnake Creek	600
Rocky Fork Creek	700
Leetonia, Independent Eagle Lake	375
Lemoyne, Quarry Pond	200
Rockland Pond	200
Luke Chute, Muskingum River	1,000
Lyndon, Buckskin Creek	375
Malta, Muskingum River	1,000
Mansfield, Walker Lake	300
Marietta, Duck Creek	1,250
Mentor, Ice Pond	75
Millersburg, Douty Creek	150
Killbuck River	225
Paint Creek	150
Nelsonville, Hocking River	625
New Concord, Muskingum River	1,000
Oakwood, Auglaize River	400
St. Marys, Auglaize River	300
Holls Pond	300
Lake St. Marys	500
St. Marys River	300
Salem, Pigeon Pond	150
Sebring, Westville Lake	375
Sidney, Tawana Creek	400
Turtle Creek	300
Warsaw Junction, Walhonding River	400
Wellington, Waterworks Pond	375
West Milton, Stillwater River	875
Woodsfield, Waterworks Pond	1,000
Xenia, Anderson Fork Creek	400
Caesars Creek	400
Little Miami River	400
Oklahoma:	
Alauma, Grooshart Lake	40
Antlers, Locke Lake	40
Ardmore, Lake Marie	25
Macks Lake	25
Enid, Clear Creek	375
Erick, Gillum's pond	300
Haddock's pond	300
Guthrie, Fairview Pond	200
Helena, Indian Pond	150
Unruh's pond	225
Ketchum, Duck Creek	2,000
Kingfisher, Uncle Johns Creek	375
McAlester, M., K. & T. Lake	115
Madill, City Lake	40
Frisco Lake	40
Lake Pettijohn	40
Mangum, Cave Creek	500
Marietta, Club Lake	25
Harvey Brothers Pond	25
Peak Pond	25
Mexhoma, East Water Hole Pond	160
Mill Creek, Blue River	75
Newkirk, Country Club Lake	375
Oklahoma City, Players Lake	200
State fish commission	3,600
Pauls Valley, Liberty Lake	400
Pawhuska, Chapman Lake	25
Hatt Lake	25
Perry, Woodruff Lake	225
Prague, Smith's pond	300
Quay, Vogler's pond	200
Seminole, Townsend's pond	225
Shawnee, Maud Lake	450
Snyder, Clear Lake	400
Spiro, Bowman's pond	150
Tulsa, Tribes Creek	25
Wister, Clear Lake	75
Pennsylvania:	
Aldham, Knickerbocker Pond	200
Pickering Creek	200
Altoona, Juniata River	1,600

Total Distribution of Fish and Fish Eggs, by Species, Fiscal Year 1919—Continued.

LARGEMOUTH BLACK BASS—Continued.

Disposition.	Number.	Disposition.	Number.
Pennsylvania—Continued.		Pennsylvania—Continued.	
Arcola, Perkiomen Creek	300	Schwenksville, Branch Creek	150
Skippack Creek	100	Perkiomen Creek	150
Avondale, White Clay Creek	300	West Swamp Creek	75
Collegeville, Perkiomen Creek	200	Selinsgrove, Middle Creek	500
Skippack Creek	100	Sellersville, Perkiomen Creek, Northeast Branch	200
Columbia, Chickies Creek	200	Slatington, Bowman Creek	100
Strickler Run	400	Empire Pond (A)	100
Susquehanna River	400	Empire Pond (B)	100
Denver, Kings Pond	200	Trout Creek Pond	200
Leeds Run	200	Somerfield, Little Sandy Creek	300
Downingtown, Brandywine Creek	200	Spartansburg, Clear Lake	200
Quarry Pond	100	Spring Mount, Branch Creek	150
Ephrata, Cocalico Creek	200	Perkiomen Creek	150
Conestoga Creek	200	Susquehanna, Susquehanna River	500
Muddy Creek	200	Troy, Sugar Creek	200
Everett, Juniata River, Raystown Branch	300	Uniontown, Corley Lake	300
Foster, Ely Lake	200	Valley Forge, Schuylkill River	100
Frazer, Hershey Mill Pond	200	Valley Creek Pond	100
Gaines Junction, Pine Creek	200	Warren, Alleghany River	300
Goldsboro, Susquehanna River	800	Conewago Creek	400
Gratersford, Branch Creek	150	Wind Ridge, South Wheeling Creek	100
Perkiomen Creek	450	Wheeling Creek	100
Green Lane, Perkiomen Creek	125	Wrightsville, Susquehanna River	1,000
Huntingdon, Juniata River	100	Yerkes, Perkiomen Creek	200
Juniata River, Raystown Branch	100	Skippack Creek	100
Standing Stone Creek	200	Zeiglersville, Perkiomen Creek	150
Lancaster, Conestoga Creek	600	South Carolina:	
Mill Creek	150	Aiken, Bauskett Pond	5,000
Landisville, Chickies Creek	200	Franklin's pond	3,000
Lewisburg, Buffalo Creek	600	Staub's pond	3,000
Bull Run	200	Tarrant's pond	3,000
Chillisquaque Creek	600	Bennettsville, Egypt Mill Pond	4,000
Penns Creek	200	McCall's pond	8,000
Spruce Creek	200	Camden, Jordan's pond	2,000
Susquehanna River	200	Swift Creek	3,000
Lititz, Hammer Creek	200	Columbia, Crystal Lake	3,000
Media, Crum Creek	300	Goodwill Pond	9,000
Ridley Creek	150	Holman's pond	2,000
Montoursville, Loyalsock Creek	500	Porter's pond	1,900
Montrose, Elk Lake	300	Sylvan's pond	225
Ely Lake	200	Creston, Boggy Gully Pond	3,000
Heart Lake	200	Darlington, Lowder Lake	750
Lake Montrose	500	Denmark, Pearson's pond	375
Norris Lake	300	Eastover, Jumping Run Pond	2,800
New Castle, Little Neshannock Creek	400	Edgefield, Mountain Creek	500
Neshannock Creek	120	Ehrhardt, Clearwater Lake	6,000
Slippery Rock Creek	400	Fort Mill, Carhertt Lake	1,000
Newton, Neshaminy Creek	150	Gary, Singley Mill Pond	2,100
Northampton, Crystal Pond	100	Gaston, Sandy Run Pond	3,000
Oaks, Perkiomen Creek	100	Great Falls, Catawba Lake	3,500
Schuylkill River	100	Greer, Mill Pond	2,800
Orbisonia, Aughwick Creek	300	Hartsville, Black Creek Pond	7,000
Black Log Creek	200	Prestwood Lake	2,000
Shade Gap Creek	100	Jefferson, Big Rocky Creek Pond	2,000
Spring Creek	100	Landrum, Hosiery Mill Pond	150
Peach Bottom, Susquehanna River	225	Langley, Aiken Manufacturing Company Pond	625
Pen Argyl, Broadhead Lake	40	Langley Mills Pond	625
Lake Pauponoming	40	Lexington, Barre Pond, Lower	300
Lesizys Pond	40	Barre Pond, Upper	600
Snydersville Creek	40	Dreher Mill Pond	600
Pequea, Otter Creek	150	Factory Pond	2,100
Susquehanna River	225	Twelve Mile Pond	2,100
Perkiomenville, Perkiomen Creek	150	Lowndesville, Rocky River	7,000
Philadelphia, Willow Grove Lake	650	Marion, Little Pee Dee River	4,000
Phoenixville, Pickering Creek	500	Monetta, Jordan's pond	2,400
Quarryville, Conowingo Creek	225	Yonce's pond	3,000
Hopkins Lake	225	Neeses, Pearson's pond	300
Octorara Creek	225	Orangeburg, Davis's pond	2,000
Rahn Station, Perkiomen Creek	150	Edisto River	1,200
Riddlesburg, Juniata River, Raystown Branch	200	Fishery Branch	1,100
Riddlesburg Pond	200	Fralick's pond	1,500
Roaring Spring, Plum Creek	300	Pearson's pond	2,400
Yellow Creek	300	Pretty Pond	2,400
Roherstown, Little Conestoga Creek	200	River Branch	1,500
St. Clair, Kaufman Pond	300	Ridge Springs, Baughman's pond	1,500
		Boatwright's pond	5,000

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

LARGEMOUTH BLACK BASS—Continued.

Disposition.	Number.
South Carolina—Continued.	
Ruby, Spring Pond	200
St. Matthews, Wannamaker's pond	1,200
Seneca, Price's pond (A)	75
Price's pond (B)	75
Springfield, Phillips Mill Pond	4,000
Steedman, Mill Branch Pond	3,000
Summerville, Smith Pond	2,100
Walhalla, Taylor's pond	75
Woodside, Lake Ida	200
York, Crystal Pond	175
South Dakota:	
Fort Pierre, Meers Pond	400
Hot Springs, Ice Pond	300
Lemmon, Flat Creek	72
Merriman, Round Lake	400
Milbank, Big Stone Lake	88
Rapid City, Spruce Pond	600
Spearfish, Johnson's pond	300
Nelson's pond	400
Spring Creek Pond	400
Webster, Allen Lake	176
Long Lake	176
Wessington, Tofflemire Lake	600
Tennessee:	
Athens, Goodfield Creek	100
Ten Mile Creek	100
Bristol, City Lake	†2,200
Chapel Hill, Dozier Pond	†3,000
Clarksville, Columbia River	†1,000
Cleveland, Wildwood Lake	†4,000
Columbia, Duck River	†21,000
Fountain Creek	900
Rutherford Creek	900
Cumberland City, Lick Creek	1,500
Erin, Wells Creek	1,000
Franklin, Harpeth River	†6,000
Gibson, Persimmon Pond	250
Kerrville, Lone Pine Lake	250
Knoxville, Lake Mahan	400
La Vergne, Buchanan's pond	†2,000
McKenzie, Clear Lake	1,500
Mayland, Sells Lake	800
Nashville, Lake Kewalco	24
Pinson, Matthews's pond	420
Rockwood, Rockwood Pond	75
Rogersville, Limestone Creek	†5,000
Shelbyville, Duck River	†10,500
Springfield, Armstrong Lake	†2,000
Old Deerlick Pond	250
Trenton, Holmes's pond	420
Tullahoma, Hurricane Creek	100
Lynchburg Mill Pond	200
Mulberry Creek	200
Wilder, Hollow Pond	80
Texas:	
Albany, Lake Diller	400
Valleyview Pond	400
Alto, Hoover's pond	580
Amarillo, Amarillo Creek, Middle Prong	300
Annona, Denison Ranch Lake	385
Grooms Lake	385
Porter Pond	385
Archer City, City Lake	1,140
Carver Lake	250
Dugan Pond	250
Arcola Junction, Clear Lake	197
Austin, Insane Asylum Lake	100
Ballinger, Coyote Creek	50
Fuzzy Creek	50
Mustang Creek	50
Pony Creek	50
Winters Lake	125
Beaumont, Holdebrand Bayou	300
Big Wells, Claybank Pond	200
Minnehaha Lake	200
Thomson's pond	200
Texas—Continued.	
Birome, Birome Pond	200
Blooming Grove, Oil Mill Pond	580
Blossom, Tomerlin's pond	385
Bonham, Bonham Club Lake	600
Boyd Club Lake	300
City Lake	1,125
Meadow Lake	300
Russell's pond	300
Brenham, Club Lake	765
Schroeder's lake	28
Brookston, McBath's pond	300
Swan Lake	300
Brownsville, Resaca de la Guerra Lake	16
Brownwood, Brooke Smith Lake	800
Club Lake	1,600
Lake Richardson	800
Burnet, Hamilton Creek	400
Spring Creek	400
Cara, Ross's pond	200
Carrizo Springs, Ehler's pond	200
Center, Runnell's pond	12
Wood Park Lake	12
Chapel Hill, Jackson Creek	17
Jackson Lake	17
Old River Lake	17
Childress, Lake Keeler	125
Chireno, Highland Pond	250
Teutsch Lake	250
Clawson, Clawson Lake	580
Cleburne, Country Club Pond	400
Clifton, Brandes Lake	200
Clute, Lake Caro	196
Lake Jackson	196
Colorado, Lone Wolf Creek	100
Columbus, Byars's pond	300
Cooper, City Lake	300
Corsicana, Burke Pond	200
Orphan Home Lake	80
Refinery Reservoirs	800
Waterworks Pond	200
Cotulla, Nueces River	80
Crockett, Bobbitt Lake	400
Elcaney Lake	400
Cuero, Cuero Creek	125
Guadalupe River	125
McCoy Creek	125
Daingerfield, Donald Dell Pond	100
Willow Lake	100
Dalhart, Rita Blanca Creek	225
De Kalb, Jones's pond	770
May's pond	385
Meneck's pond	770
Russell's pond	770
Denton, Bayless's pond	70
Wilkerson's pond	40
Detroit, Moss Bank Pond	385
Price's pond	385
Diboll, Conn's pond	500
Dublin, Rucker's pond	400
Electra, City Lake	125
Meadow Lake	125
Elgin, Burke's pond	25
Carlson's pond	25
Fisheris Lake	35
Fromme's pond	25
Sandahl's pond	25
Engle, Veselka's pond	250
Ennis, Gatewood's pond	200
Herring Lake	200
Sand Lake	200
Falfurrias, Monten's pond	180
Ferris, Malone's pond	350
Wester's pond	350
Flatonia, Vyojala Lake	300
Wheeler Lake	300
Fletcher, Village Creek	12

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

LARGEMOUTH BLACK BASS—Continued.

Disposition.	Number.	Disposition.	Number.
Texas—Continued.		Texas—Continued.	
Floresville, Galea's pond	12	Leroy, Hay Barn Pond	200
Fort Worth, Fosdick Lake	600	Schroeder's pond	200
Lake Louise	30	Lindale, Lindale Lake	373
Lake Worth	1,512	Tom Lake	373
Franklin, Garner's pond	200	Linden, Fant Lake	75
Freeport, Sulphur Lake	196	Llano, Stribling's pond	400
Frisco, Henson's pond	300	Longview, Martin's pond	620
Garrison, Fern Lake	250	Lott, City Lake	420
Garrison Lake	750	Lueders, Brazos River, Clear Fork	800
Parrott's pond	500	Little Fish Creek	800
Gaston, Round Lake	125	Layford, Ritama Lake	12
Gatesville, Coryell Creek	464	McCoy, McGhee's pond	200
Cow House Creek	928	Mabank, Croft's pond	200
Plum Creek	464	Madisonville, Robinson's pond	24
Table Rock Creek	464	Manor, Chamberlain's pond	75
Giddings, Albers Home Lake	420	Marlin, Fortune Lake	200
Clear Knot Pond	35	Johnson Lake	200
Holman Lake	15	Reed's pond	200
Menzel's pond	17	Shields Lake	200
Moerbe's pond	420	Mart, Willow Lake	400
Pin Oak Lake	17	Menard, Celery Creek	75
Saenger's pond	35	Coglin Creek	75
Schatte's pond	420	Llano River, forks of	75
Gilmer, Club Pond	200	San Saba River	75
Mud Lake	300	Wallick Lake	75
Oaks Lake	200	Meridian, Bosque River	200
Goldthwaite, Lake Hull	250	Mertens, Myrick's pond	200
Gonzales, Willard's pond	420	Mesquite, Dallas Mesquite Lake	220
Grand Saline, Big B Lake	500	Jobson Lake	220
Carrington Lake	250	Lawrence Lake	220
Clark's lake	300	Mexia, Jones's pond	125
Germany Pond	300	Morgan's pond	125
Goode's pond	300	Midland, Bryam Place Pond	100
Luce's pond	300	Mineola, Club Lake (A)	374
Thomas Lake	250	Club Lake (B)	374
Westwood Lake	250	Club Lake (C)	374
Grapeland, Baker Lake	400	Goldsmith's pond (A)	373
Bowman's pond	400	Goldsmith's pond (B)	373
Spring Lake	400	Hart Pond	373
Grapevine, Chamblee's pond	300	Reed's pond	374
Greenbrier, Crow Lake	773	Sarber Club Lake	373
Indian Lake	774	Wells Lake	373
Mountain Lake	773	Willow Lake	374
Greenville, Ward Club Lake	115	Millett, Eclipse Pond	100
Groesbeck, Groesbeck Pond	350	Mineral Wells, Country Club Lake	500
Hallsburg, Hall Twin Lake	200	Elm Creek	400
Harriss Valley, Harriss Pond	200	Holt's pond	400
Hearne Sandy Creek	650	Hubbard's lake	400
Henderson, Bennett's pond (A)	115	Moody, Acree's pond	200
Bennett's pond (B)	115	Stampede Lake	130
Deason Lake	115	Mount Calm, Clark Lake	580
Dorsey's pond	115	Tank Lake	580
Honey Island, Cochran's pond	12	Wolfe Creek Lake	580
House, Saw Mill Pond	197	Mount Pleasant, Ellis-Kelly Club Lake	300
Thompson Lake	197	Mount Vernon, Blakey's pond	300
Hubbard, Cedar Pond	580	Mullen, Leisure Land Lake	400
Huntington, Carter-Kelly Pond	200	Naples, Sullivan Sanford Pond	1,600
Huntsville, Felder's pond	400	Navasotta, Zulch Lake	100
Irene, Irene Lake	200	Newcastle, Terrell's pond	300
White's pond	200	Newsome, Elwood Lake	200
Jacksonville, Crysup's lake	63	Newton, Big Cow Creek Pond	225
Haberlie's lake	63	Caney Creek	225
Jasper, Sandy Creek	12	Eligoh Lake	225
Jayton, Hackberry Lake	200	Gunter's pond	225
Sand Rock Lake	200	New Willard, Lumber Company Pond	580
Kemp, Fogleman's pond	200	Nordhein, Butler Creek	125
Huston Lake	200	Normangee, Ellison Pond	125
Spence's pond	200	Northrup, Falkes Pond	420
Willow Lake	200	North Zulch, H. & T. C. pond	125
Kerrville, Blue Bell Lake	1,600	South Zulch Pond	125
Kingsville, Santa Gertrudis Creek	24	Olney, Adam's pond	†700
Kountze, Cypress Creek	200	Paige, Fox Pond	18
Lampasas, Burleson Creek	400	Rohde's pond	17
McCrea's pond	400	South End Pond	17
School Creek	400	Paint Rock, Ames Lake	125
Sulphur Creek	800	Palestine, Elkhart Lake	400
Laredo, Willow Lake	80		
Laure, Lambright's pond	200		

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

LARGEMOUTH BLACK BASS—Continued.

Disposition.	Number.
Texas—Continued.	
Paris, Conrady Lake	400
Frazier Lake	400
Jenkins's pond	400
Jones's pond	400
Loraine Lake	400
Scott Pond	400
Passadena, Sanders's pond	70
Phelps, Cline's mill pond	400
Pittsburg, Cotter-Willes Pond	100
Lily Pond	300
Port Arthur, Number Seven Lake	300
Quanah, Groesbeck Creek	225
Randolph, Cat Tail Lake	300
Rhome, Railroad Pond	600
Richmond, Smithers Lake	300
Riviera, Pataluma Pond	12
Rochelle, Sellman Lake	100
Rock Island, Moore's pond	125
Rosebud, Caddo Club Lake	420
City reservoirs	840
Ellison's pond	420
Round Rock, Brushy Creek	300
San Angelo, Concho River	125
Kiowa Creek	125
San Antonio, Breckenridge Park Lake	270
Harrigan Lake	300
McIlvaine's pond	75
Pipe Creek Lake	600
Zoological Park Pond	90
San Augustine, Ballard's pond	12
San Benito, Novotney Lake	12
Sanger, Duck Creek	300
Sarita, Santa Rosa Lake	12
Seguin, Geronimo Creek	300
Guadalupe River	300
Sherman, Chapman Lake	40
Cottonwood Lake	1,600
Lakewood Pond	24
Rogers's pond	15
Seven Mile Pond	15
Spur, J. 2 Pond	200
Stafford, Lester Lake	300
Stanford, City Lake	675
Fish Creek	800
Harrell's pond	200
Sterling City, North Concho River	125
Strawn, Burton Lake	150
Lyra Lake	150
No. 3 Lake	200
Streetman, Sims's pond	125
Sugar Land, Biltmore Lake	300
Sulphur Springs, McLaughlin's pond	100
Sweetwater, Santa Fe Lake	400
Taylor, Burns Lake	400
Temple, Lake Polk	250
Tenaha, Columbus Lake	24
Terrell, Cate Ranch Lake	510
Cottonwood Lake	220
Texarkana, Chub Lake	385
Moores Lake	1,600
Temple Lake	600
Thorndale, Ellison's pond	400
Graves's pond	400
Timpson, Porterfield's pond	325
Witcher's pond	500
Trinity, Payton's pond	400
Troup, City Waterworks Pond	620
Tyler, Chinquapin Lake	373
Country Club Lake	373
Lakewood Lake	373
Park Club Lake	200
Starr Lake	300
Valley Mills, Lake Elmo	200
Vernon, Anderson Lake	125
Voth, Pine Island Creek	12
Waco, Armstrong Lake	50
Axtell Lake	50
Bosque Home Lake	464
Texas—Continued.	
Waco, Cooper's pond	50
Elm Lake	464
Escondida Lake	464
Everman Lake	50
Goodman Valley Lake	464
Hickory Creek	464
Mann Lakes	464
Maupin Lake	464
Meadors Lake	464
Oak Lake	514
Slone Lake	464
Smith's pond	50
Spring Lake	50
Teal Lake	50
Waco Club Pond	100
White Rock Farm Pond	50
Wildwood Lake	464
Waelder, Hopkins Lake	300
Walnut Springs, Katy Lake	400
Webster, Rice Canal Pond	196
Welfare, Joshua Creek	400
Wichita Falls, Hodge Lake	250
Wichita Valley Pond	200
Winnsboro, Lake Erie	100
Wills Point, Lake Crystal	220
Owens's pond	220
Thorn Lake	220
Utah:	
Marysville, Panguitch Lake	500
Price, Kilpack's pond	300
Vermont:	
Barton, Parker Pond	300
Brattleboro, Lily Pond	75
Virginia:	
Abingdon, McBroom Mill Pond	300
Alta Vista, Stanton River	200
Amherst, Campbell's pond	100
Piney Creek	300
Arratt, Johnson Creek Pond	100
Basic, Shenandoah River, South Fork	880
Beaver Dam, Beaverdam Pond	40
Blacksburg, Sinking Creek	165
Blackstone, Dobson's pond	120
Blaine, Blackwater River	400
Bon Air, Cedar Crest Creek Pond	1,700
Boydton, Sydnor Old Mill Pond	110
Burkeville, Ellett's pond	80
Charlottesville, Willow Spring Pond	300
Clifton, Morris's pond	200
Crimora, South River	80
Danville, Lanier Pond	300
Dry Fork, Harper's pond	200
Edinburg, Forest Service	300
Emporia, Jones Pond	200
Taylor's pond	50
Fredericksburg, Harris Pond	600
Miller Lake	600
Rappahannock River	2,200
Hanover, Lake Aylett	160
Harriston, South River	80
Henry, Smith River	700
Jefferson, Sandy Creek	500
Kinsale, Schools Pond	200
Lee Hall, Small Stream	200
Lexington, Kerrs Creek	300
Maple Mill Pond	200
Louisa, Williams Mill Pond	400
Lynchburg, Lee's pond	156
Maiden, Hening's pond	300
Martinsville, Brown's pond	200
Massaponax, Massaponax Pond	400
Meadow, Eberhard's mill pond	200
Meadow Pond	300
Minshull's pond	200
Middletown, Cedar Creek	300
Milford, White's pond	40
Moccasin Gap, Holston River, North Fork	400
New Castle, Craigs Creek	400

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

LARGEMOUTH BLACK BASS—Continued.

Disposition.	Number.	Disposition.	Number.
Virginia—Continued.		Wisconsin—Continued.	
New Castle, Johns Creek	200	Bloomer, Island Lake	125
Orange, Mt. Sharon Pond	200	Jim Lake	125
Robertson River	300	Lake Como	125
Palmyra, Rivanna River	300	Little Beaver Lake	125
Pamplin, Baker's pond	200	Long Lake	125
Parksley, Mason's pond	160	Marsh Miller Pond	125
Pemberton, Flannigan Mill Pond	400	Mud Lake	125
Trenholm Pond	400	Pickerel Lake	125
Petersburg, Ashen Creek	400	Pike Lake	125
Philpot, Smith River	400	Rice Lake	125
Port Republic, Shenandoah River, South Fork	120	Rock Lake	125
		Round Lake	125
Richmond, Jollys Mill Pond	160	Salisbury Lake	125
King William Mills Pond	120	Shattuck Lake	125
Rocky Mount, Giles Mill Pond	400	Town Line Lake	125
Power Pond	400	Bowler, Heaberlein Lake	40
Suffolk, Lake Savage	400	Centuria, Deer Lake	125
Sweet Hall, Custis Lake	120	Chippewa Falls, City Pond	700
Swords Creek, Clinch River, Maiden Spring Fork	400	Davis Lake	700
		Lake Wissota	700
Vickers, New River	160	Oneils Creek	700
Wakefield, Airfield Lake	400	Yellow River	450
Walker Ford, James River	400	Clayton, Mississippi River	a 1,700
Waverly, Shingleton Pond	400	Coloma, Carter Lake	450
West Point, Goddins Pond	450	Pleasant Lake	450
Wilson, Hobbs's pond	80	Comstock, Pipe Lake	400
Woodstock, Shenandoah River, North Fork	400	Cumberland, Beaver Dam Lake	500
		Sand Lake	400
West Virginia:		Devils Lake, Devils Lake	600
Arden, Laurel Creek	300	Donaldson, Big Portage Lake	100
Berkley Springs, Sleepy Creek	300	Dollar Lake	100
Central, Arnold Creek	240	Landing Lake	100
Charles Town, Evetts Run	200	Little Portage Lake	100
Shenandoah River	1,400	Pink Eye Lake	100
Clarksburg, Davisson Run	540	Eau Claire, Dell Pond	375
Orla Lake	800	Elcho, Otter Lake	100
Dundon, Big Buffalo Creek	300	Pine Lake	200
Elm Grove, Big Wheeling Creek	700	Elmwood, Eau Galle Mill Pond	200
Martinsburg, Patterson's pond	500	Fisher Lake, Fisher Lake	300
Paw Paw, Cacapon River	375	Fond du Lac, Long Lake	300
Philippi, Sugar Creek	200	Moon Lake	200
Romney, Potomac River, South Branch	2,250	Mullet Lake	200
		Round Lake	200
Walkersville, Monongahela River, North Branch	200	Twin Lake	300
		Wolf Lake	300
Weston, Monongahela River, West Fork	800	Fox Lake, Fox Lake	750
		Fredonia, Milwaukee River	625
Wisconsin:		Galesville, Lake Marinuka	500
Alma, State fish commmission	3,600	Gordon, Big Eau Claire Lake	100
Baraboo, Dell Creek Pond	150	Bony Lake	100
Ellendale Springs Pond	150	Ox Lake	100
Fern Dell Pond	150	Pickerel Lake	100
Gray Slough Pond	150	Robinson Lake	100
Loch Mirror Bay	150	Sherman Lake	100
Mirror Lake	450	Hartford, Collins Lake	375
Narrows Creek	150	Mud Lake	375
Osborne Point Pond	150	Murphy-Maloy Lake	500
Pickerel Slough Pond	150	Hatfield, Lake Arbutus	120
Ringling Landing Pond	150	Hawthorne, Lake Minnesung	100
Smiths Slough Pond	150	Lake Nebagammon	100
South Bay Pond	150	Hayward, Andrew Lake	100
Spring Brook	150	Anthony Lake	100
Timmes Mill Pond	150	Arrow Pond	100
Twin Slough Pond	150	Ayers Lake	100
Bayfield, Siskiwit Lake	280	Balsam Lake	100
Beaver Dam, Beaver Dam Lake	1,200	Barney Lake	100
Birchwood, Birch Lake	70	Bean Lake	100
Black River Falls, Black River	300	Big Lake	100
Douglas Lake	300	Blue Lake	100
Morrison Creek	300	Booze Lake	100
Stebbins Lake	300	Cable Lake	100
Blair, Trempealeau River	500	Calhoun Lake	100
Bloomer, Ax Handle Lake	125	Carpenter Lake	100
Big Beaver Lake	125	Cass Lake	100
Boot Lake	125	Chippewa Lake	100
Chain Lake	125	Claire Lake	100
Cornell Lake	125	Como Lake	100
Hennenian Lake	125	Cook Lake	100

a Rescued from overflowed lands and restored to original waters.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

LARGEMOUTH BLACK BASS—Continued.

Disposition.	Number.	Disposition.	Number.
Wisconsin—Continued.		Wisconsin—Continued.	
Hayward, Crab Lake	100	Hayward, Witz Lake	100
Crandell Lake	100	Hazlehurst, Lake Katherine	200
Crystal Lake	100	Wind Pudding Lake	200
Dandy Lake	100	Heafford, Bass Lake	200
Eagle Lake	100	Manson Lake	200
Elbow Lake	100	Stag Lake	200
Elmo Lake	100	Hudson, Burkhardt Pond	300
Ford Lake	100	Independence, Bugle Lake	2,725
Forest Lake	100	Elk Lake	1,650
Fox Lake	100	La Crosse, Mississippi River	a 11,360
Frances Lake	100	Lake Beulah, Lake Beulah	400
Fredic Lake	100	Lake Millicent, Bingo Lake	100
Frog Lake	100	Boscoe Bay Lake	100
George Lake	100	Bubar Lake	100
Giblin Lake	100	Crow Lake	100
Glenwood Lake	100	Eagle Lake	100
Glover Lake	100	Heart Lake	100
Hallie Lake	100	Lost Lake	100
Harriett Lake	100	Lower Pike Lake	100
Harry Lake	100	Pike Lake	100
Hazen Smith Lake	100	Pine Tree Lake	100
Helen Lake	100	Spring Lake	100
Hellweg Lake	100	Swanson Lake	100
Henry Lake	100	Twin Lakes	100
Hemlock Lake	100	Lake Nebagammon, Lake Nebagammon	300
Horse Lake	100	Laona, Birch Lake	300
Island Lake	100	Silver Lake	300
Jag Lake	100	Lavalle, Durens Mill Pond	200
James Lake	100	Lavalle Pond	300
Jane Lake	100	Madison, State fish commission	1,400
Jewell Lake	100	Mattoon, Baker Lake	100
Katinka Lake	100	Dollar Lake	200
Lenroot Lake	100	Johnson Lake	200
Linden Lake	100	Menomonie, Asylum Bend Lake	200
Little John Lake	100	Atlasta Lake	200
Little Long Lake	100	Caryville Lake	200
Luce Lake	100	Cedar Lake	200
Maple Lake	100	Cutoff Lake	200
Mary Lake	100	Doyle Lake	200
Mayo Lake	100	Dunnville Coutoff Lake	200
Minnie Lake	100	Eighteen Mile Lake	200
Muscalonge Lake	100	Goose Lake	200
New Lake	100	Hay River	200
North Lake	100	Lake Menomonie	200
Ore Lake	100	Manbeek Cutoff Lake	200
Owen Lake	100	Manley Bend Lake	200
Papoose Lake	100	Miller Lake	200
Peter Lake	100	Moore Farm Lake	200
Pike Lake	100	Mud Lake	200
Pine Lake	100	Pitt Lake	200
Pohaquon Lake	100	Red Cedar River	200
Rainbow Lake	100	Rowe Lake	200
Razor Back Lake	100	Stump Lake	200
Rivkin Lake	100	Wilson Lake	200
Rock Lake	100	Mercer, Trude Lake	1,000
Sady Lake	100	Muscoda, Cross Lake	300
St. John Lake	100	Dixon Lake	300
Sand Lake	100	High Bank Lake	300
Shadow Lake	100	Kendall Lake	200
Shell Lake	100	Mill Creek Pond	300
Sims Lake	100	Moore Lake	300
Sisco Lake	100	Puffenrod Lake	300
Slim Lake	100	Narrows, Cedar Lake	500
Spirit Lake	100	Nashota, Pine Lake	400
Spruce Lake	100	New Lisbon, Fish Lake	375
Squirrel Lake	100	Lake Juneau	375
Star Lake	100	Lake Van Kuren	375
Storm Lake	100	Lemonweir River	375
Sunday Lake	100	Little Yellow River	375
Tener Lake	100	Yellow River	375
Tompkins Lake	100	New Richmond, Willow River	60
Thomas Lake	100	Norrie, Bass Lake	100
Toba Lake	100	Halfway Lake	100
Turtle Lake	100	Lake Go To It	100
White Sand Lake	100	Lake Wausau	100
Wildcat Lake	100	Long Rice Lake	100
Wilson Lake	100	Mayflower Lake	100
Winneabo Lake	100	Mud Lake	100
Witch Lake	100		

a Rescued from overflowed lands and restored to original waters.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

LARGEMOUTH BLACK BASS—Continued.

Disposition.	Number.
Wisconsin—Continued.	
Norrie, Pike Lake	100
Rice Lake	100
Road Lake	100
Short Portage Lake	100
Smith Lake	100
Stony Lake	100
Twin Lake	100
Park Falls, Oxbow Lake	70
Shnurs Lake	70
Pembine, Bass Lake	150
Lake Nine	150
Lindquist Lake	200
Rock Lake	150
Phelps, Big Bass Lake	100
Big Twin Lake	100
Lake No See Um	100
Little Bass Lake	100
Long Lake	100
Phillips, Bass Lake	100
Conners Lake	100
Cranberry Lake	100
Crane-Chase Lake	100
Dardis Lake	100
Deer Lake	100
Grassy Lake	100
Lake Sixteen	100
Lake Ten	100
Leroy Lake	100
Little Dardis Lake	100
Long Lake	100
Lunt Lake	100
Minnow Lake	100
Musser Lake	100
Price Lake	100
Riley Lake	100
Round Lake	100
Worcester Lake	100
Prentice, Worcester Lake	300
Reedsburg, Dell Pond	200
Mirror Lake	300
Reserve, Grindstone Lake	300
Lake Court Oreilles	300
Little Lake Court Oreilles	200
Rhinelander, Bass Lake	25
Ben Sweet Lake	25
Boom Lake	25
Crescent Lake	25
Hancock Lake	25
Jennie Weber Lake	25
Lake George	15
Lake Julia	15
Lake Thompson	15
Marshall Lake	15
Moen Lake	15
Oneida Lake	15
Pearl Lake	15
Pine Lake	15
Shepard Lake	15
Silver Lake	50
Squash Lake	50
Stone Lake	50
Sugar Camp Lake	75
Thunder Lake	75
Town Line Lake	75
Washburn Lake	75
Wolf Lake	75
Rib Lake, North Harper Lake	60
North Spirit Lake	60
South Harper Lake	60
Rice Lake, Tuscobia Lake	300
Richfield, Friess Lake	375
Rosholt, Mill Pond	750
Salmo, Siskiwit Lake	100
Sauk City, Crystal Lake	80
Koenig Mill Pond	80
Lake Swenson	80
Sheboygan Falls, Lake Ellen	625
Long Lake	625
Wisconsin—Continued.	
Sheboygan, Pigeon Lake	625
Solon Springs, Cabin Lake	100
Lake St. Croix	100
Sullivan Lake	100
Twin Lake	100
South Range, Lyman Lake	200
Superior, Amnicon Lake	75
Dowling Lake	100
Mast Lake	100
Three Lake, Columbus Lake	100
Deer Lake	100
Eagle Chain of Lakes	75
Island Lake	100
Laurel Lake	100
Little Fork Lake	100
Long Lake	100
Medicine Lake	100
Planting Ground Lake	100
Round Lake	75
Spirit Lake	100
Thunder Lake	75
Tomahawk, Bass Lake	150
Burrows Lake	100
Buteau Lake	100
Clear Lake	150
Crescent Lake	100
Crystal Lake	150
Deer Lake	150
Half Moon Lake	150
Hancock Lake	100
James Lake	150
King Pond	150
Lake Clara	150
Lake George	100
Lake Julia	100
Lake Thompson	100
Manson Lake	100
Muscalonge Lake	100
Reno Lake	150
Rice Lake	100
Road Lake	150
Round Lake	150
Sawyer Lake	100
Seven Isle Lake	100
Silver Lake	100
Smith Lake	150
Somo Lake	150
Somo River	150
Swamp Lake	150
Tomahawk River	150
Wisconsin River	150
Wisconsin River Pond	150
Wabeno, Ada Lake	150
Bass Lake	75
Leach Lake	150
Little Long Lake	75
Perch Lake	75
Range Line Lake	75
Richardson Lake	75
Shoe Lake	150
Trump Lake	150
Wausau, Big Rib River	750
Lake Wausau	750
Pine River	750
West Bend, Big Cedar Lake	500
Wild Rose, Kosel Lake	60
Round Lake	60
Winter, Barber Lake	70
Brunett Lake	70
Mud Lake	70
Wyoming:	
Cheyenne, Lake Minnehaha	600
Sloans Lake	600
Mexico: Nacozari, Huacal Dam	5,000
Total[a]	† 425,045 1,100,420

[a] Exclusive of 805 fry and 3,360 fingerlings lost in transit.

Total Distribution of Fish and Fish Eggs, by Species, Fiscal Year 1919—Continued.

SMALLMOUTH BLACK BASS.

Disposition.	Number.
Alabama:	
Birmingham, Black Creek Pond	300
Central Waterworks Lake	400
Tuscambia, Town Creek	400
Arkansas:	
Hardy, Forty Island Creek	†2,000
Spring River	†4,000
Hot Springs, Alum River	†3,000
Glazy Pole Creek	†4,000
Saline River, Middle Fork	†4,000
Saline River, South Fork	†3,000
Imboden, Spring River	†5,000
Mammoth Spring, Myatt River	†3,000
Spring River and branches	960
Tracey Creek	200
Mountainburg, Cedar Creek	300
Frog Bayou	300
Colorado: Littleton, Ken-Caryl Lakes	900
Delaware: Wilmington, Brandywine Creek	300
Georgia: Toccoa, Toccoa Creek Pond	200
Illinois:	
Antioch, Third Lake	675
Lawrenceville, Beaverdam Pond	200
Robison Lake	200
Indiana:	
Crandall, Indian Creek	1,000
Depauw, Blue River	400
Indianapolis, Buck Creek	600
Eagle Creek	†4,000
Fall Creek	†4,000
Jeffersonville, Silver Creek	400
White River	†4,000
Muncie, White River	600
New Albany, Graff Pond	200
Indian Creek	400
Little Indian Creek	400
Silver Creek	600
Silver Creek, Muddy Fork	400
Paoli, Lick Creek	300
St. Paul, Flat Rock River	†5,000
Sellersburg, Balknap Lake	†5,000
Globe Lake	200
Terre Haute, Wabash River	600
Iowa:	
Chester, Upper Iowa River	†500
Manchester, Maquoketa River	820
Mason City, Lime Creek	1,500
Kentucky:	
Adairville, Red River	200
Red River, South Fork	100
Cynthiana, Licking River, South Fork	600
Lawrenceburg, Salt River	800
Louisville, Douglas Park Lake	†5,000
South Park, South Park Lake	†3,000
Maine:	
Bath, Lake Nequassett	†1,500
Lily Pond	†1,000
Boothbay Harbor, Campbell Pond	†1,500
Bridgton, Highland Lake	†2,000
Ellsworth, Walker Pond	60
Fryeburg, Kezar Lake	†2,500
Lovewell Pond	†1,500
Gray, Dry Pond	200
Livermore Falls, Davids Pond	†1,500
Oakland, Little Pond	†1,500
Poland, Lake Thompson	285
Sandy Creek, Woods Pond	†3,500
Maryland:	
Cumberland, Castleman River	400
Evitts Creek	400
Fifteen Mile Creek	300
Sidling Hill Creek	400
Town Creek	400
Wills Creek	400
Williamsport, Potomac River	800
Massachusetts:	
Great Barrington, Lake Buel	†3,000
Lake Garfield	†3,000
Huntington, Norwich Pond	†1,500
Westfield River, East Branch	†1,500
Lee, Goose Pond	†4,000
Greenwater Pond	†1,000
Laurel Lake	†2,000
Lenox, Lake Mahkeenac	†1,500
Stockbridge Lake	†1,500
Littleton, Spectacle Pond	80
Richmond Furnace, Cranberry Pond	†500
Shelburne Falls, Ashfield Pond	†1,500
Deerfield River	†1,500
Reservoirs 2, 3 and 4	†4,500
Michigan: Gladwin, Lucas Lake	400
Minnesota: Red Wing, Mississippi River	a2,190
Missouri:	
Aurora, Flat Creek	100
Rolla, Big Piney Creek	100
Cane Spring Creek	300
Little Piney River	100
Salem, Meremec River	400
Sparta, Finley Creek	100
New Hampshire:	
Keene, Spofford Lake	†1,500
Newport, Rocky Bound Pond	†1,500
Plymouth, Ellsworth Pond	†1,000
West Ridge, Perley Lake	†1,500
New Jersey:	
Hackettstown, Budd Lake	300
Guard Lock Pond	400
Mountain Lake	600
Newburg Pond	300
Waterloo Pond	300
McAfee, Wildwood Lake	300
New Mexico: Santa Fe, Catron's Pond	200
New York:	
Montcalm Landing, Eagle Lake	†1,500
Lake George	†500
Port Henry, Deadwater Pond	†200
Lake Champlain	†500
Lake Nokomis	†500
Ledge Lake	†200
Wawamaissa Lake	†200
Whitehall, Metawee River	†500
North Carolina:	
Etowah, Bluff Pond	100
Lenoir, Buffalo Creek Pond	200
Rutherfordton, Coxe's Pond	450
Green River	900
Green River Lake	450
Upper Broad River	925
Oklahoma: Oklahoma City, State fish commission	400
Pennsylvania:	
Bushkill, Deer Lake	200
Delaware River	300
Forest Lake	300
Lake Tament	300
Canton, Lake Nepahwin	300
Easton, Delaware River	400
Echo Lake, Echo Lake	300
Kennet, Pusey Lake	300
Lancaster, Conestoga Creek	200
Lititz, Conestoga Creek	300
Pequea, Pequea Creek	300
Pittston, Susquehanna River	1,000
Slatington, Maiden Creek	300
Trout Run, Little Pine Creek	700
Lycoming Creek	300
West Chester, Brandywine Creek	300
Whitford, Blue Hole Pond	300
Rhode Island:	
Apponaug, Fresh Pond	†1,000
Gorton Pond	†1,000

a Rescued from overflowed lands and restored to original waters.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

SMALLMOUTH BLACK BASS—Continued.

Disposition.	Number.
Rhode Island—Continued.	
Apponaug, Woquogonsett Pond	† 1,000
Providence, Gorton Pond	† 1,000
Herring Pond	† 2,000
Moswausicut Lake	† 1,500
Quiduick Reservoir	† 1,500
Southwood Ponds	† 500
Woquogonsett Pond	† 1,500
Woonsocket, Scheeneconet Pond	† 1,500
Tennessee:	
Bluff City, Holston River	450
Chattanooga, Middle Creek	† 1,000 500
North Chickamauga Creek	1,000
Johnson City, Watauga River	600
Murfreesboro, Stone River	† 16,000
Rock Island, Caney Fork River	† 3,000
Vermont:	
Castleton, Lake Bomoseen	† 500
Hydeville, Lake Bomoseen	† 500
Virginia:	
Ashby, Shenandoah River	† 5,000
Emporia, Meherrin River	180
Virginia—Continued.	
Emporia, Three Creeks	180
Front Royal, Shenandoah River	† 5,000
Harriston, South River	† 2,500
Hot Springs, Jackson River	† 6,000
Stanley, Shenandoah River, South Fork	† 5,000
West Virginia:	
Charleston, Elk River	† 9,000
Glendon, Birch River	† 12,000
Patterson Creek, Patterson Creek	500
Webster Springs, Elk River, Back Fork	† 6,000
White Sulphur Springs, Meadow Pond	840
Wisconsin:	
Fond du Lac, Devil Lake	200
Lake De Neveu	400
Mercer, Trude Lake	3,600
Total [a]	† 195,700 43,745

ROCK BASS.

Disposition.	Number.
Alabama:	
Anniston, Coldwater Creek	300
Nesbit pond	400
Willett's Pond	200
Arkansas:	
Bentonville, Bella Vista Lake	600
Eldorado, Hudson's pond	524
Harrison, Buffalo River	200
Cecil Creek	200
Flat Rock Creek	200
Mill Creek	200
Lewisville, Spirit Lake	786
St. Joe, Cave Creek	100
Springdale, North Osage Creek	400
Patton Lake	400
Richland Creek	400
Colorado: Longmont, Dawson Lake	1,090
Delaware: Wilmington, Sedgely Lake	200
Georgia:	
Roberta, Lowe's pond	1,000
Rome, Dykes Creek	1,000
Stilesville, McGowan's pond	150
Stone Mountain, Nicholes's pond	150
Illinois: Warren, Apple River	2,500
Indiana:	
Greensburg, Kessing's pond	200
Jeffersonville, Q. M. Depot Pond	600
Muncie, Main Lagoon	800
Iowa:	
Manchester, Maquoketa River	2,250
Spirit Lake, State fish commission	13,000
Kansas:	
Kincaid, Grindstone Lake	200
Silver Spring Lake	200
Kentucky:	
Cave City, Phoebe Ann Pond	500
Horse Cave, Page's Pond	500
Louisville, Lake Lansdowne	600
Olive Hill, Tiger Creek	300
Rich Pond, Willow Shade Pond	1,000
Roulette, Burke's pond	500
South Park, South Park Lake	1,650
Sullivan, Amerson's pond	300
Maryland:	
Easton, Shannahan's pond	200
Hagerstown, Antietam Creek	1,200
Lewistown, State fish commission	2,900
Robinson, Magothy River	300
Michigan:	
Jackson, Browns Lake	400
Michigan Centre Pond	400
Twin Lake, Twin Lakes	400
West Lake	400
Minnesota: Homer, Mississippi River	[b] 200
Mississippi: Friar Point, Mississippi River	[b] 440
Missouri:	
Aurora, Flat Creek	600
Cabool, Crater Pond	200
Cuba, Huzzah Creek	800
Joplin, Sloan's pond	250
Thomas Lakes	400
Houston, Arthur Creek	400
Reeds, Young's pond	200
Rolla, Little Piney Creek	400
St. James, Bourbois Creek	400
Sparta, Finley Creek	200
Steelville, Meremec River	400
Montana: Corinth, Springdale Pond	20
New Jersey: White House Station, Paul Poppe Pond	200
New Mexico: Cutter, Elephant Butte Lake	200
New York: Davenport Center, Charlotte River	200
North Carolina:	
Hendersonville, Imbersley Pond	500
Norlina, Fleming Pond	400
Largo Pond	350
Lees Pond	325
Owens Creek Pond	400
Rogers Lake	325
Shocco Lake	500
North Wilkesboro, Hendren's pond	550
Reddies River	1,000
Raleigh, Doctor's Lake	500
Hood Mill Pond	500
Milburnie Pond	400
Neuseoco Club Pond	3,750
Peachtree Pond	1,000
Rural Hall, Pstree's pond	500
Smithfield, Holts Lake	600
Woodside, Lake Lottie	300
Ohio:	
East Monroe, Lees Creek	100
Greenfield, Paint Creek	100

[a] Exclusive of 4,900 fry and 1,125 fingerlings lost in transit.
[b] Rescued from overflowed lands and restored to original waters.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

ROCK BASS—Continued.

Disposition.	Number.
Ohio—Continued.	
Greenfield, Rattlesnake Creek	100
Rocky Fork Creek	100
Oklahoma: Lyons, Harper's pond	200
Pennsylvania:	
Doylestown, North Branch Creek	200
Swartzlander Mill Pond	200
Meadowbrook, Farm Lake	200
South Carolina:	
Columbia, Messer Mill Pond	300
St. Mathews, Millwood Pond	300
Tennessee:	
Cleveland, Fillauer's pond	500
Franklin, West Harpeth River, Murphy Fork	1,000
Harriman, Lovely Springs Pond	1,200
Morristown, Light Company Pond	335
Murfreesboro, Stone River	6,000
Prospect Station, Griffin's pond	1,000
Texas:	
Brenham, Brenham Club Lake	110
Center, Hillcrest Lake	60
Clifton, Dahl's pond	45
Floresville, Father Zarb Pond	75
Fort Worth, Westside Lake	65
Jacksonville, Alexander Lake	50
Churchill Lake	50
Crysup Lake	50
Deveraux Lake	50
Dublin Lake	50
Goodson Lake	50
Texas—Continued.	
Jacksonville, Haberlie Lake	50
Hood Pond	50
Lawrence Lake	50
Long Lake	50
McReynolds Lake	50
Park Lake	50
Pussler Lake	50
Kemp, Shaw Lake	36
Lampasas, Culver's pond	50
Loraine, Bauman's pond	50
McDade, Bermuda Pond	50
Moody, Gent Pond	45
Overton, Strickland Lake	50
Pittsburg, Willow Lake	50
Stamford, City Lake	75
Virginia:	
Ashland, Willow Spring Pond	200
Buffalo Station, Buffalo Creek	50
Danville, Strawberry Pond	200
Emporia, Fountain Creek	800
Slagel's pond	600
Three Creeks	1,100
Yarrell Pond	600
Seven Mile Ford, Rice's pond	100
Thaxton, McMillan's pond	200
Whiteacre, Toms Creek	1,000
Wisconsin: Galesville, Lake Marinuka	150
Total [a]	75,460

WARMOUTH BASS.

Mississippi: Tupelo, Gum Pond	1,060

SUNFISH (BREAM).

Alabama:	
Abbeville, Cowpen Creek	500
Danzey's pond	250
East Choctawhatchee River	1,000
Espys Lake	1,000
Hutto's pond	1,000
Starling's pond	1,000
Vann's mill pond	750
Alberta, Atkins's pond	300
Alexander City, Hillabee Creek	800
Andalusia, Langston's pond	1,500
Anniston, Allen's mill pond	450
Bynum's mill pond	400
Hughes Mill Pond	450
Loyd's mill pond	400
Nesbitt's pond	450
Arlington, Dismukes's pond	300
Bankston, Gardner's pond	300
Gladden's pond	600
Belle Mina, Beaverdam Creek	900
Benton, Bozeman Pond	900
Black Belt Pond	750
Birmingham, Hollis Pond	400
Booth, Shanks's pond	600
Thompson's pond	600
Calhoun, Bell's pond	600
Carrollton, Kilpatrick's pond	200
Miller's pond	200
Childersburg, DeLoach's pond	200
Chocoloco, Brickyard Pond	200
Clio, Ruch's pond	300
Comer, Holly Creek	300
Cooper, Edwards's pond	300
Dadeville, McIntosh's pond	200
Alabama—Continued.	
Falkville, Key's pond	300
Fort Deposit, Davis's pond	1,200
Garland, Joyner's pond	300
Geigers, Liars Lake	3,600
Goodwater, Power Pond	1,400
Greenville, L. & N. Pond	500
Hannon, Three Springs Pond	200
Headland, Baker's pond	500
Hardwick's pond	1,000
Jennie Lind Pond	1,000
Pasture Lake	1,250
Spivey Mill Pond	750
Huntsville, Braham Spring Pond	300
Jasper, Bankhead's pond	300
LaFayette, Hall's pond	200
Louisville, Flournoy's pond	150
Mathison's pond	1,000
Warr's pond	300
Luverne, Kendrick-Ruff Pond	250
Matthews's pond (A)	500
Matthews's pond (B)	500
Simmons's pond	500
McCalla, Bell's pond	1,350
Marion, Perry Lake	1,000
Woodfin's pond	600
Midway, Willow Lake	150
Millport, Cash's pond	300
Millry, McLemore's pond	900
Martin's mill pond	900
Milstead, Spring Hill Pond	500
Monroe, Lake Dark	1,500
Montgomery, Line Creek	400
Shooting Club Lake	2,700

[a] Exclusive of 1,400 lost in transit.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

SUNFISH (BREAM)—Continued.

Disposition.	Number.
Alabama—Continued.	
Murphy Station, Roberts Pond	500
New Brockton, Folsom's pond	1,000
Oneonta, Little Warrior River	400
Opelika, Crest Lake	800
Davis's pond	400
Orrville, Lake Wallace	200
Moseley's pond	200
Pelham, Palmeto Mill Lake	1,500
Peterman, Brantley's pond	1,200
Pine Hill, Stokes Pond	600
Repton, Dee's pond	300
Riderwood Upper Choclahana Lake	900
Roanoke, Johnson's pond	300
Samson, McCall Pond	2,000
Seale, Benton's pond	450
Dudley's pond	450
Sellers, Boyd's pond	250
Selma, Stoddard's pond	400
Whites Pond	400
Speigner, Mortar Pond	900
Three Notch, Thornton's pond	150
Troy, Jones's pond	250
Youngblood Mill Pond	1,500
Tunnel Springs, Hardee's pond	600
Arizona:	
Benson, Boyles's pond	120
Fry's pond	120
Merrill's pond	120
Cochise, Wilson's pond	120
Globe, Sleeping Beauty Pond	300
Nogales, Pasture Pond	120
Arkansas:	
Arlberg, Abb Smith Creek	452
Arlberg Creek	452
Little Red River	904
Sugar Camp Creek	452
Barber, Indian Pond	200
Barnett, Little Red River	904
Meadow Creek	452
Black Rock, Black River	a 3,345
Bonanza, Smith Pond	400
Elba, Hurricane Creek	200
Moon Creek	200
Red River	200
Emerson, Randall's pond	200
Stevens's pond	400
Everton, Anderson Pond	400
Harrison, Buffalo River	678
Carlton Branch	500
Cove Creek	500
Farmer's pond	452
Murray's pond	232
Heber Springs, Peter Creek	678
Red River	904
Sulphur Creek	904
Higden, Little Red River, South Fork	1,130
Hunter, Engell's pond	400
Leola, Lea's pond	150
Marshall, Bear Creek	678
Big Creek	678
Buffalo River	678
Rocky Creek	678
Spring Creek	678
Miller, Cave Creek	1,130
Little Red River	1,130
Ozan, Smisson Farm Pond	300
Pangburn, Little Red River	904
Pine Bluff, Kennelwood Pond	400
Poe, Indian Creek	452
St. Joe, Cave Creek	200
Mill Creek	400
Spirit Lake, Spirit Lake	1,200
Texarkana, Hogans Lake	300
Waldo, Hosier's pond	500
California:	
Mecca, Dunn's pond	120
San Diego, Ellens Pond	200
Colorado: Paonia, Winter's pond	400
Connecticut:	
Hartford, State fish commission	1,400
Wintergreen Pond	400
Stamford, Robins's pond	200
Delaware: Wilmington, Bellevue Pond	600
Florida:	
DeFuniak Springs, Chipley Park Lake	200
Greensboro, Cowen's pond	450
Tampa, Strawberry Lake	600
Georgia:	
Alamo, Kent's pond	200
Alvaton, Swygert's pond	500
Americus, Muckalee Creek	300
Athens, Hodgson's pond	300
Mitchell's pond	300
Atlanta, Brookhaven Lake	750
Norris's pond	250
Augusta, Belding's pond	150
Erchert Pond	300
Tarver's pond	300
Whitney Pond	450
Beach, Sweet's pond	500
Bishop, Hattaway's pond	100
Boneville, Mill Creek Pond	450
Bostwick, Anderson's pond	100
Buena Vista, Bridge Creek Pond	600
Shorts Mill Pond	150
Chipley, Culpepper Pond	150
Clarkston, Pasture Pond	100
Coffee, Harrison's pond	250
Colbert, Fortson's pond	150
Hopkins's pond	150
Columbus, Bussey's pond	150
Christian's pond	150
Lummus Pond	150
Conyers, Farmer's pond	100
Walker's pond	200
Cordele, Williams's pond	600
Crawfordsville, Chapman Creek	400
Cox Lake	150
Hardins Creek	200
Cyclonetta, Cycloneta Ponds	500
Douglas, Railway Pond	450
Dublin, Dreamland Lake	350
Edna, Lake Kilkare	500
Fitzgerald, Dickson's mill pond	500
Fort Valley, Magnolia Pond	600
Fowlstown, Dasher's pond	400
Guysie, McCrea's pond	500
Hampton, Hampton Pond	500
Higgston, Morris's pond	450
Hogansville, Lazylands Pond	500
Holly Springs, Steeles Pond	250
Macon, Hogans Branch	450
Sherwood Creek	300
Madison, Oak Branch Pond	200
Manor, Greezy Creek	250
Monroe, Lake Linda	300
Towler's pond	100
Mystic, Willis's pond	300
Nicholls, Kirkland's pond	500
Lott's pond	500
Saginaw Ponds	500
Ocilla, Holt Pond	300
Paulk's pond (A)	600
Paulk's pond (B)	450
Paulk's pond (C)	300
Pavo, McGraw Pond	500
Raymond, Raymond Lake	750
Reynolds, Horse Creek Pond	450
Rockingham, Camp Head Creek	500

a Rescued from overflowed lands and restored to original waters.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

SUNFISH (BREAM)—Continued.

Disposition.	Number.	Disposition.	Number.
Georgia—Continued.		Kentucky:	
Rockingham, Delge's pond	500	Adairsville, Red River	100
Rome, Coosa Moore Lake	150	Bowling Green, Blue Hole Pond	400
Sale City, LaNona Belle Pond	250	Campbellsville, Public Utilities Lake	800
Screven, Mill Pond	500	Covington, Michels Pond	400
Soperton, Gillis's pond	300	East Cairo, Ohio River	a 106,000
Sparta, Rockby Pond	200	Haags Spur, Clear Lake	a 15,000
Stephens, Cheney's pond	200	Prairie Lake	a 12,000
Stilesboro, McGowan's pond	150	Horse Cave, Hedgepeth's pond	200
Stockton, Crews Pond	750	Jeffersonville, Q. M. Depot Pond	600
Swainsboro, Little Ohoopee River	450	Lawrenceburg, Carroll's pond	600
Watson's pond	300	Witherspoon Lake	400
Sycamore, Ray's pond	300	Lebanon, Nattingly's pond	200
Tallapoosa, Cauthen's pond	300	Louisville, Bear Grass Creek	11,000
Summerlin's pond	350	Cane Run Creek	10,000
Temple, McGarity's pond	200	Harrods Creek	6,000
Thomson, Bowden's pond	300	Lake Lansdowne	5,200
Tifton, Cypress Log Lake	500	Lyndon, Willowbrook Pond	200
Gum Pond	750	Mayfield, McCall's pond	450
Price's pond	750	Mount Sterling, Greene's pond	300
Webb's pond	500	Reid's pond	400
Tucker, Tanner's pond	150	Munfordville, Wood's pond	150
Ty Ty, Black Gum Pond	500	Nichlasville, Hooverhurst Ponds	600
Gibbs Pond	500	Olmstead, Paris's pond	200
Valdosta, Jones's pond	750	Science Hill, Keller's pond	200
Vidalia, Rountree's pond	200	Shelbyville, Clear Creek	200
Willacoochee, Paulk's pond (A)	500	South Park, South Park Lake	15,500
Paulk's pond (B)	750	Trenton, Crusher Pond	300
Woodbury, Gilbert's pond	150	Maple Lawn Pond	300
Powers-Sims Pond	450	Willard, Porter's pond	200
Illinois:		Louisiana:	
Alpha, Crescent Lake	800	Bayou Sara, Parker Pond	1,000
Apple River, Apple River	600	Homer, Shaw's pond	400
Aquaka, Mississippi River	a 3,215	Longstreet, Longstreet Pond	175
Blanding, Mississippi River	a 1,750	Mansfield, Wemple's pond	405
Cairo, Mississippi River	a 50,000	Rushton, Breedlove's pond	450
Dallas City, Lake Cooper	a 5,965	Wakefield, Cutrer's pond	500
Freeport, Yellow Creek	200	Maryland:	
Galena, Mississippi River	a 2,838	Aberdeen, Glenburnie Pond	200
Meredosia, Illinois River	a 18,500	Baltimore, Gwynn Oak Lake	125
Meredosia Bay	a 1,400	Glendale, Folly Run	600
New Boston, Mississippi River	a 15,335	Great Falls, Potomac River	600
Nora, Apple River	800	Hoods Mill, Patapsco River	200
Quincy, Spring Lake	1,600	Lansdowne, Sulphur Spring Lake	200
Sand Prairie, Mississippi River	a 25,425	Laurel, Waskey's pond	200
Scales Mound, Apple River	600	Lewistown, State fish commission	1,415
Scioto Mills, Richland Creek	250	Owings, Sewell Pond	200
Yellow Creek	250	Riverdale, Heurich's pond	800
Stonefort, Hill Farm Pond	400	Massachusetts:	
Warren, Apple River	1,000	Concord, Punkstasset Pond	200
Winslow, Pecatonica River	200	Lowell, Ames Pond	600
Indiana:		Michigan:	
Brazil, American Sewer Pipe Pond	450	Crystal Falls, Lake Marie	55
Cambridge City, Paul's pond	400	Little Tobin Lake	55
Cicero, Bandonner's pond	200	Railroad Lake	55
Corydon Junction, Hartman's pond	200	Tobin Lake	55
Eddy, Dallas Lake	200	Gwinn, Norine Lake	200
Elberfield, Fiedler's pond	150	Holton, Horseshoe Lake	250
Huntingburg, Ferdinand Lake	300	Norwegian Lake	250
Indianapolis, Sugar Creek	200	Houghton, Lake Eva	220
New Albany, Blue Itasca Pond	200	Munising, Annie River	110
Falling Run Creek	400	Minnesota:	
Ramsey, Fairview Pond	200	Arco, Lake Stay	400
Iowa:		Homer, Mississippi River	a 610,200
Bellevue, Mississippi River	a 615	Red Wing, Mississippi River	a 8,950
Fairport, Mississippi River	a 1,869	Rochester, Lake Florence	150
Fort Madison, Dobson's pond	400	Lake Shady	700
Lime Springs, Upper Iowa River	1,250	Mayo Park Pond	200
Lovillia, McDonald's pond	400	Stockton, Bigelow's pond	500
Manchester, Maquoketa River	1,600	Tamarack, Round Lake	600
Pleasant Creek, Mississippi River	a 30,900	Mississippi:	
Smiths Ferry, Mississippi River	a 11,110	Amory, Spring Lake	600
Wyalusing, Mississippi River	a 6,000	Ashwood, Hughes's pond	500
Yellow River, Mississippi River	a 250	Thompson's pond	500
Kansas:		Bay Spring, Willow Spring Pond	600
Garnett, Cedar Creek	500	Canton, Big Lake	1,200
Parsons, Club Ponds	500	Ring's pond	600
Pittsburg, Country Club Lake	800	Round Lake	900

a Rescued from overflowed lands and restored to original waters.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

SUNFISH (BREAM)—Continued.

Disposition.	Number.
Mississippi—Continued.	
Centerville, Cox's pond	1,000
Midway Pond	500
Montrose Pond (A)	1,000
Montrose Pond (B)	500
Mayfield's pond	500
Columbus, Bank's pond	600
Lake Willis	600
Myrtle Terrace Lake	600
Crawford, Richard's pond	900
Decatur, Spivey's pond	1,200
Duffee, Calvert's pond	200
Durand, Dodd's pond	300
Elliott, Mier's pond	500
Fayetteville, Coffey's pond	500
Friar Point, Mississippi River	a39,025
Grenada, Pasture Pond	500
Hazlehurst, Carter's mill pond	300
Jackson, Clearwater Pond	900
Fraiser's pond	900
Hughes's pond	900
Jones's pond	300
Williams's pond	600
Kosciusko, Fenwick's pond	600
Jamison's pond	300
Lauderdale, Wadsen's pond	600
Meridian, Asylum Pond	600
City Lake	1,800
Country Club Pond	900
Wagner Pond	400
Waterworks Lake	1,500
Mississippi City, Green Creek Pond	300
Monticello, Fair River Pond	250
Mooreville, Ward Mill Pond	300
Natchez, Kenilworth Pond	1,000
Morgantown Pond	1,000
Peale's pond	1,000
Neshoba, Blue Fountain Pond	600
Newton, Everett's pond	900
Nola, Prine's pond	250
Picayune, Puyper's pond	900
Pocahontas, Middleton's pond (A)	900
Middleton's pond (B)	600
Raymond, Meadow View Pond	1,000
Newman's pond	200
Sandersville, Sycamore Farm Pond	200
Selma, Lake Catherine	500
Sumrall, Blue Pond	500
Terry, Marlow's pond	600
Tupelo, Pierce's pond	200
Voosburg, Donald's pond	200
West Point, Palo Alto Pond	600
Woodville, Harris Pond	500
Henderson's pond	1,000
Lake Clement	200
Lewis's pond	200
McGehee's pond	200
Morgan's pond	500
North Pond	500
Ogden's pond	1,000
Sessions's pond	1,000
Wallace's pond	1,000
Westmoreland Pond	500
Word's pond	500
Missouri:	
Buffalo, Evans's pond	300
Callao, Wainscott's pond	200
Carthage, Coolbrook Lake	50
Goodman, Ritter's pond	100
Joplin, Moore's pond	150
Lebanon, Ballinger Pond	250
Little Blue, Dirks Lake	400
Merwin, Corbin Lake	800
Neosho, Hickory Creek	364
Pleasant Hill, Baldwin Lake	300
Scahder's pond	600
Rolla, Gasconade River	1,000
North Spring Creek	500
Missouri—Continued.	
Saginaw, Walker's pond	200
St. James, Meramec River	750
Springfield, Kunzman's pond	300
Sweet Springs, Shrader's pond	300
Nevada: Fallon, Cottonwood Canon Creek	150
New Jersey:	
Branchville, Lake of the Woods	200
White House Station, Paul Poppe Pond	200
New Mexico:	
Aztec, Animas Sunfish Pond	200
Cambridge, Nunns Ranch Pond	150
Cutter, Elephant Butte Lake	600
Deming, Ruebush's pond	150
Lake Valley, Greeley Lake	240
Las Cruces, Hackberry Pond	200
Orange, Justis's pond	120
Portales, Eden Valley Ranch Pond	450
Goodwin's pond	120
Raton, Lojek's pond	400
Vaughn, Lucero's pond	300
New York:	
Albany, State fish commission	100
Altamont, Summit Club Lake	400
Central Valley, Leo's pond	200
Derby, Shepard's pond	100
Far Rockaway, Emmerich's pond	400
Knowlesville, Spring Brook Pond	100
Monticello, Von Isakoric's pond	100
North Carolina:	
Badin, Tallahassee Lake	2,000
Benson, Hardee's pond	200
Bessemer, Beaverdam Pond	400
Bryson City, Tuckaseigee River	800
Burlington, Big Alamance Pond	500
Little Alamance Pond	500
Moser Mill Pond	400
Stony Creek Pond	500
Cary, Jones's pond	200
Knight's pond	200
Clayton, Hinton's pond	200
Clinton, Mill Pond	300
Corinth, Buckhorn Pond	400
Elkin, Laster's pond	500
Fayetteville, Bonnie Brook Pond	400
Garner, Wilder's pond	200
Goldsboro, Little River	500
Woods Mill Pond	300
Graham, Clapp's pond	400
Greensboro, Lakewood Farm Pond	500
Hazlewood, Welch's pond	200
Hope Mills, Parker's pond	600
Julian, Chockley Pond	500
Kinston, Kennedy's mill pond	250
Kittrell, Clear Pond	100
Knightdale, Willow Club Pond	300
Liberty, Major Hill Pond	500
Louisburg, Jones Mill Pond	300
Lumberton, McMillen Pond	400
Mine Creek Pond	400
Macclesfield, Warren's pond	200
Marshville, Marsh's pond	200
Moore's pond	200
Mayodan, Balsam Pond	500
Maysville, White Oak River	1,300
Morven, Martin's pond	600
Williamspon's pond	800
Mount Airy, Brooks's pond	1,000
Nashville, May's pond	400
North Wilkesboro, Hendren's pond	900
Hickory Grovoe Pond	500
Pee Dee, Blewett Falls Pond	1,800
Pittsboro, Hinton's pond	200
Nooe's pond	100
Potecasi, Hicks Mill Pond	400
Raleigh, Hinton Creek Pond	300

a Rescued from overflowed lands and restored to original waters.

Total Distribution of Fish and Fish Eggs, by Species, Fiscal Year 1919—Continued.

SUNFISH (BREAM)—Continued.

Disposition.	Number.
North Carolina—Continued.	
Raleigh, Milburnie Pond	300
Neuseoco Club Pond	1,000
Roseboro, Willow Oaks Pond	200
Ruffin, Cox's pond	500
Salisbury, Harkey Pond	500
Statesville, Beechwood Pond	500
Washington, Broad Creek Mill Pond	300
Hodges's pond	200
Upper Broad Creek	200
Wise, Hicks's pond	200
North Dakota:	
Petrel, City Lake	600
Margason's pond	400
Ohio:	
Akron, Turkey Foot Lake	200
Cincinnati, Bullskin Creek Pond	100
Fernwood, Floyd's pond	100
Oklahoma:	
Alderson, Mountain Lake	200
Ardmore, Lake Provence	400
Claremore, Walnut Lake	625
Helena, Schmidt's pond	80
Kiowa, Barranger's pond	100
Meridian, McDaniel's pond	80
Oklahoma City, Lord's pond	160
Pauls Valley, Williams's pond	160
Spiro, Bowman's pond	200
Stillwater, Needell's pond	80
Westville, Haupt's pond	100
Pennsylvania:	
Chicora, Craig's pond	100
Downingtown, McIlvaine's pond	200
Doylestown, Cooks Run	100
Deep Run	100
Elmhurst, Lake Worth	200
Everett, Juniata River, Raystown Branch	300
Gap, Ellmaker Creek	200
Kaylor, Sugar Creek Pond	100
Lancaster, Pequea Creek	300
McKeesport, Margaret Pond	100
Mars, Overbrook Pond	100
Moscow, Bearbrook Lake	100
Hartford Pond	100
Ives Pond	100
Rattlesnake Pond	100
Sayre Pond	100
Water Company Creek	100
Wilson Pond	100
New Bethlehem, Leatherwood Creek	100
Marshall's pond	100
Pen Argyl, Broadhead Lake	100
Johnsonville Pond	100
Lake Pauponoming	100
Lesizys Pond	100
Seguins Pond	100
Smalls Pond	100
Snydersville Creek	100
Phoenixville, Valley Forge Creek	450
Safe Harbor, Meadow Valley Run	250
St. Claire, Kaufman Pond	300
Saltsburg, Marshall's pond	200
Slatington, Meadow Brook Pond	200
Wynnewood, Indian Pond	100
Rhode Island: Tiverton, Church's pond	100
South Carolina:	
Aiken, Beaver Pond	2,000
Belton, Belton Mills Pond	1,000
Blaney, Brown's pond	800
Camden, Little Pine Tree Pond	600
Central, Issaqueena Mill Pond	400
Chapin, Kelly's pond	400
Charleston, Laurel Spring Pond	600
Clover, Clover Cotton Pond	400
Columbia, Cobb's pond	800
Lawrence's pond	1,600
South Carolina—Continued.	
Edgefield, Hollingsworth's pond	1,000
May's pond	750
Edgemoor, Atkinson Pond	400
Edmund, Thresher Pond	300
Graniteville, Coldwater Creek	1,200
Greenville, Southern Power Pond	600
Greenwood, Beaverdam Creek	400
Reedy Creek	400
Willow Brook Pond	400
Langley, Langley Mill Pond	1,200
Town Creek Pond	300
Livingston, Strauss's pond	200
Lydia, Marcos Mill Pond	800
McBee, Cedar Creek	400
Gum Pond	400
Sand Hill Pond	200
McCormick, Huggins's pond	400
Mars Bluff, Black Creek	1,400
Mount Croghan, Klondike Pond	300
Mountville, Holmes's pond	600
Newberry, Matthews's pond	200
North Augusta, McKie's pond	1,600
Orangeburg, Edgewood Pond	400
Edisto River	1,000
Fish Pond	600
Fogle Pond	600
Zeiglers Pond (A)	500
Zeiglers Pond (B)	600
Pacolet, Bonner's pond	200
Pageland, Rock Pond	600
Rock Hill, Fennell's pond	800
South Land Pond	600
Stony Creek Pond	400
Rockton, Castles's pond	400
Ruby, McGregor's pond	200
Moore's pond	200
Wilson's pond	300
St. Matthews, Hair's pond	800
High Hill Creek	1,400
Pine Creek Pond	800
Riley's pond	1,200
Spigener's pond	800
Salley, Cook's pond	1,250
Sharon, Rainey's pond	200
Thomson's pond	200
Society Hill, Carrigan Pond	600
McCown Mill Pond	500
Rocky Dundee Pond	500
Spring Pond	600
Sumter, Barkley's pond	300
Midway Park Pond	800
Walhalla, Owens's pond	200
Woodford, Stear Branch Pond	200
York, Wallace's pond	200
South Dakota: Elk Point, Aase's pond	200
Tennessee:	
Jackson, Long's pond	1,000
Lexington, Henry Pond	600
Perryville, Brandon's pond	200
Persia, Barn Pond	500
Roland Pond	500
Woodland Pond	1,000
Tasso, Byrd's pond	500
Texas:	
Alice, Adams's pond	†500
Alleyton, Willow Creek Lake	50
Alto, Willow Pond	100
Aquilla, Robertson's pond	25
Austin, Willow Lake	180
Bangs, Hall's pond	25
Bardwell, Sullivan's pond	50
Wright's pond	50
Bedias, McAdams's pond	50
Wilson's pond	50
Ben Arnold, Crevan Lake	32
Big Wells, Webb's pond	†250
Buck, Bigby's pond	50

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

SUNFISH (BREAM)—Continued.

Disposition.	Number.
Texas—Continued.	
Caro, Lackawana Pond	50
Childress, Crew's pond	25
Clawson, Clawson Lake	100
Coleman, Hillside Lake	25
Collinsville, Hollingshead's pond	65
Corsicana, Burk Pond	146
Derden Upper Pond	†250
Eden's pond	36
Refinery Reservoir	†250
Crockett, Burton Lake	33
Eastside Lake	33
Hack Lake	33
Ossunna Lake	33
Tanglefoot Lake	33
Cross Plains, Hart's pond	25
DeKalb, May's pond	20
Denton, Hoffman's pond	65
Siboll, Conn's pond	50
Dilley, Edwards's pond	†250
Ennis, City Lake	†150
New Lake	†150
Eustace, Cook's pond	30
Falfurias, Lakota Pond	†250
Franklin, Dowdy's pond	35
Fredericksburg, Vorauer's pond	50
Gary, Graves's pond	90
Hall's pond	30
Lane Pond	30
Roper's pond	45
Giddings, Mertink's pond	32
Gorman, Scales's pond	25
Grapeland, Fulton's pond	33
Herod Lake	33
Green, Dadisman's pond	30
Hallsburg, Holmes Lake	400
Henrietta, Gilbert's pond	50
Houston, Hyacinth Pond	52
Huntington, Wilroy's pond	50
Huntsville, Hampton's pond	51
Lake Birmingham	51
Jacksonville, Alexander's pond	100
Club Lake	100
Crysup Lake	100
Haberle's pond	100
Hillside Lake	100
Lane Lake	100
Park Lake	100
Ragsdale's pond	100
Smith Lake	100
Tucker Lake	100
West Lake	100
Kemp, Shaw Lake	50
Kingsville, Flato's pond	50
Lampassas, Townsen's pond	35
Laredo, Rio Grande Pond	†250
Leggett, Hayes Lake	26
Llano, Collier's pond	35
Lockhart, Harris's pond	32
Lometa, Conradt's pond	85
Longview, Lake Devernia	65
Pecan Lake	75
Loraine, Baumann's pond	50
Louise, Ivy's pond	50
McDade, Bermuda pond	50
Mabank, Chamblee's pond	50
Marion, Hoese's pond	26
Linne's pond	50
Voigt's pond	50
Memphis, Browder Lake	25
Lake Bryant	25
Midland, Bryan Place Pond	40
Mineola, Bowdoin's pond	50
Sand Spring Pond	50
Nacogdoches, Harris Pond	100
Texas—Continued.	
Nacogdoches, Mamie Ross Lake	50
West End Pond	50
Wilson's pond	100
Navasota, Zulch Lake	125
Paint Rock, Lacy's pond	25
Palestine, Campbell Pond	35
Crystal Lake	35
Pearsall, Malone's pond	†250
Pecan Gap, Shady Pond	25
Pleasanton, McCoy's pond	†500
Purdon, Moore's pond	100
San Angelo, Adams's pond	25
San Augustine, Fults's pond	45
San Marcos, Alexander's pond	80
San Saba, Moore's pond	25
Walter's pond	25
Sarber, Club Lake	30
Sherman, Chapman Park Lake	195
Stamford, City Lake	200
Sterling, North Concha Pond	25
North Concha River	25
Stratford, Beaver Lake	25
Streetman, Grayson's Lake	37
Taft, Willow Lake	80
Taylor, Thonig's pond	65
Teague, Henderson's pond	38
Thorndale, Heintze's pond	65
Noack's pond	65
Schiwalt's pond	65
Worley's pond	65
Timpson, Garrison Lake	50
Vernon, Harriss Pond	25
Waelden, Rabb's pond	40
Whitesboro, Crabtree's pond	65
Whitesboro Stock Pond	65
Winnsboro, Willow Lake	75
Virginia;	
Alton, Coleman's pond	200
Ashland, Willow Spring Pond	100
Beaver Dam, Beaver Dam Pond	200
Boone Mill, Turner's pond	300
Claverdale, Dalesville College Pond	200
Edinburg, Forest Service	400
Elkton, Wyant's pond	100
Farmville, Waterview Pond	100
Forest Depot, Parks's pond	400
Galax, Kenworthy Pond	200
Haysi, Big Sandy River, Russell Fork	2,000
Jarratt, Mayes's pond	200
Limeton, Mauck's pond	100
Manasas, Clover Hill Pond	200
Middletown, Cedar Creek	200
Milford, Terrell Pond	100
Petersburg, Lees Mill Pond	500
Suffolk, Lake Cahoun	800
Lake Kelly	2,000
Sweet Hall, Custis Lake	300
Troutville, Harvey Pond	200
Victoria, Smith's pond	100
Yale, Stottart's pond	300
Zuni, Nebtill Mill Pond	800
West Virginia;	
Charles Town, Shenandoah River	600
Clarksburg, Davisson Run	400
Point Pleasant, Squawk Creek	200
White Sulphur Springs, White Sulphur Springs Lake	900
Wisconsin;	
Japan Slough, Mississippi River	a 1,500
La Crosse, Mississippi River	a 15,500
La Forge, Big Slough Pond	500
Evans Pond	500
Kickapoo River	500

a Rescued from overflowed lands and restored to original waters.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

SUNFISH (BREAM)—Continued.

Disposition.	Number.
Wisconsin—Continued.	
La Forge, Seeley Pond	500
Slayback Pond	500
Lake Millicent, Clubine Lake	100
Heart Lake	100
Huber Lake	100
Manson, Manson Lake	450
Mason, Kern Lake	750
Muscoda, Big Cat Pond	300
Elston Lake	300
Muscoda, Hoyt Lake	300
Jones Lake	300
Pospickial Lake	300
Somerset, Pine Lake	400
Sicor Lake	400
Total[a]	1,350,115 †3,050

PIKE PERCH.

Disposition.	Number.
Connecticut:	
East Hampton, Midwood Pond	†100,000
Hazardville, Scantic River	†200,000
New Canaan, Lake Sisowitt	†200,000
Stratford, Fresh Pond	†200,000
Wilmantic, Wamgumbaug Lake	†300,000
Illinois:	
Antioch, Druse Lake	†300,000
Grayslake, Druse Lake	†400,000
Indiana:	
Columbia City, State fish commission	*8,050,000
La Grange, Mongo Mill Pond	†240,000
Logansport, Fletcher Lake	†160,000
Iowa:	
Fraser, Des Moines River	†600,000
Rockford, Shell Rock River	†600,000
Spirit Lake, State fish commission	*5,000,000
Kentucky: Louisville, Ohio River	†1,500,000
Massachusetts:	
East Walpole, Bird Mill Pond	†100,000
Forge Village, Forge Pond	†200,000
Framingham, Waushakum Pond	†200,000
Great Barrington, Lake Garfield	†100,000
Hudson, West Pond	†100,000
Lowell, Knopps Pond	†100,000
Merrimack River	†200,000
Round Pond	†100,000
Newburyport, Lake Attitash	†500,000
Palmer, State fish commission	*5,100,000
Michigan:	
Bay City, Saginaw Bay	†3,200,000
State fish commission	*288,800,000
Bergland, Lake Gogebic	†600,000
Beulah, Crystal Lake	†600,000
Brighton, Worden Lake	†200,000
Calumet, Medora Lake	†150,000
Channing, Lake Helen	†150,000
Charlevoix, Cunningham Lake	†1,000,000
Lake Michigan	†6,000,000
Matchett Lake	†1,000,000
Crystal Falls, Deer River	†250,000
Fortune Lake	†150,000
Lake Marie	†150,000
Michigamme River	†200,000
Tobin Lake	†100,000
Dunham, Lake Celeste	†150,000
Ewen, Ontonagon River	†200,000
Gwinn, Bass Lake	†150,000
Little Lake	†200,000
Meal Lake	†150,000
Iron River, Chicagoan Lake	†300,000
Stanley Lake	†200,000
Sunset Lake	†200,000
Ishpeming, Beaver Creek	†100,000
Grass River	†150,000
Mink Creek	†50,000
Mulligan Creek	†100,000
Otter Creek	†200,000
Silver Lake	†200,000
Little Lake, Godin's lake	†50,000
Republic, Martel Lake	†150,000
Milwaukee Lake	†150,000
Michigan—Continued.	
Roscommon, Higgins Lake	†600,000
St. Ignace, St. Martins Bay	†400,000
Traverse City, Boardman Lake	†400,000
Watersmeet, Anderson Lake	†150,000
Weelington Tank, Bass Lake	†100,000
Miller Lake	†100,000
Minnesota:	
Chisholm, Clearwater Lake	†100,000
Dewey Lake	†100,000
Island Lake	†100,000
McCormick Lake	†100,000
Shoepack Lake	†100,000
Crookston, Mill Pond	†250,000
Deer River, Deer River	†500,000
Erskine, Head Lake	†100,000
Lake Lena, Lake Lena	†100,000
Lake Ten, Lake Ten	†100,000
New Hampshire:	
Claremont, Rockybound Pond	†200,000
Meredith, Lake Waukewan	†300,000
Nashua, Horseshoe Pond	†200,000
Robinson Pond	†200,000
Warren, State fish commission	*6,000,000
New Jersey:	
Branchville, Culver Lake	†200,000
Denville, Cedar Lake	†200,000
New York:	
Albany, State fish commission	*60,000,000
Cobleskill, Bear Gulf Lake	†100,000
Roosman Vlie Lake	†200,000
Congers, Rockland Lake	†300,000
Cornwall, Popolo Lake	†300,000
Highland Falls, Roe Lake	†100,000
New York City, Aquarium	*2,000,000
Peekskill, Lake Mohegan	†200,000
Pleasant Valley, Bowers Pond	†200,000
Port Henry, Lake Champlain	†400,000
Westport, Deadwater Lake	†200,000
North Dakota:	
Bottineau, Lake Mettigoshee	†600,000
Wimbleton, Spiritwood Lake	†200,000
Ohio:	
Columbus, Scioto River	†300,000
Isle St. George, Lake Erie	†9,700,000
Kellys Island, Lake Erie	†10,000,000
Lake View, Indian Lake	†300,000
Middle Bass, Lake Erie	†10,000,000
Port Clinton, Lake Erie	†5,000,000
Put in Bay, Lake Erie	†15,000,000
Sandusky, Lake Erie	†10,000,000
Toledo, Lake Erie	†10,000,000
Pennsylvania: Erie, State fish commission	*15,050,000
Rhode Island: Providence, Wallum Lake	†200,000
Tennessee: Manchester, Duck River	†200,000
Vermont:	
Bennington, Barber Pond	†200,000
Lake Hancock	†200,000
North Bennington Pond	†200,000
Woodford City Big Pond	†200,000

[a] Exclusive of 3,520 fingerlings lost in transit.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

PIKE PERCH—Continued.

Disposition.	Number.	Disposition.	Number.
Vermont—Continued.		Wisconsin—Continued.	
Brattleboro, Connecticut River	†300,000	Couderay, Namakagon Lake	†100,000
Hunts Meadow Lake	†100,000	Rice Lake	†200,000
Sunset Lake	†100,000	Round Lake	†200,000
West River	†100,000	Spring Lake	†200,000
Burlington, State fish commission	*16,200,000	Tener Lake	†100,000
Canaan, Wallis Pond	†200,000	Gordon, Bardon Lake	†200,000
Enosburg Falls, Lake Carmi	†400,000	St. Croix Lake	†200,000
Hardwick, Lake Greenwood	†400,000	La Crosse, Black River	†5,000,000
Lake Champlain, Lake Champlain	†60,000,000	Mississippi River	a 10,710
Rocky Point, Groton Pond	†400,000	Tomahawk, Big Rice Lake	†100,000
Vergennes, Otter Creek	†200,000	Clear Lake	†150,000
Wells, Lake St. Catherine	†750,000	King Pond	†100,000
Wells River, Connecticut River	†300,000	Little Somo River	†100,000
Windsor, Runnemead Pond	†200,000	Muskallonge Creek	†100,000
Wisconsin:		Muskallonge Lake	†100,000
Chippewa Falls, Lake Wissota	†400,000	Pickerel Lake	†100,000
O'Neills Creek	†200,000	Rice River	†100,000
Couderay, Bass Lake	†100,000	Silver Lake	†100,000
Bear Lake	†100,000	Skanawan Creek	†100,000
Big Bass Lake	†250,000	Skanawan Lake	†100,000
Big Chetek Lake	†200,000	Somo River	†100,000
Big Couderay Lake	†150,000	Spirit River	†100,000
Blueberry Lake	†150,000	Tomahawk River	†100,000
Chief Lake	†250,000	Winter, Bass Lake	†100,000
Devils Lake	†100,000	Black Dan Lake	†100,000
Hunter Lake	†250,000		
Knudson Lake	†150,000		*406,200,000
Lake Weirgor	†100,000	Total b	†175,550,000
Little Couderay Lake	†100,000		10,710

YELLOW PERCH.

Disposition.	Number.	Disposition.	Number.
Arizona:		Maryland—Continued.	
Globe, Roosevelt Lake	800	Broad Creek, Potomac River	†19,209,940
Williams, Cataract Ponds	625	Cumberland, Potomac River	200
Connecticut:		Potomac River, North Branch	200
Bristol, Old Pond	†200,000	Piscataway Creek, Potomac River	†19,209,940
Pine Lake	†200,000	Swan Creek, Potomac River	†9,604,970
Greenwich, Wildwood Lake	†100,000	Massachusetts: Pittsfield, Pontoosuc Lake	†800,000
Hartford, State fish commission	1,625	Michigan: Brighton, Big Worden Lake	300
Meridian, Hanover Pond	†300,000	Minnesota:	
Stamford, Robins's pond	250	Homer, Mississippi River	a 2,208,020
District of Columbia: Highway Bridge, Potomac River	†2,500,000	Red Wing, Mississippi River	a 3,110
Illinois:		Mississippi: Meridian, Waterworks Lakes	1,250
Alexander, Davenport Lake	375	Missouri:	
Apple River, Apple River	150	Neosho, State fish commission	*160,000
Galena, Mississippi River	a 18		†40,000
Meredosia, Illinois River	a 5,900	Newton, Hearrell Creek	†90,000
Nora, Apple River	300	St. Louis, Wabash Club Pond	1,000
Quincy, Spring Lake	625	Montana:	
Scales Mound, Fevre River	150	Glendive, Yellowstone River	360
Warren, Fevre River	600	Miles City, Yellowstone River	420
Indiana:		New Jersey:	
Huntingburg, Ferdinand Lake	125	Butler, Hennions Lake	80
Indianapolis, White River	125	Hackettstown, State fish commission	*21,500,000
Kimmell, Lake Lucid	200	Palisades, Overpeck Creek	80
Iowa:		Towaco, Surprise Lake	80
Bellevue, Mississippi River	a 190	New York:	
Harpers Ferry, Mississippi River	a 40,000	Cape Vincent, St. Lawrence River	†2,000,000
Le Mars, Dalton Pond	740	Grass Bay, St. Lawrence River	†3,000,000
Manchester, Maquoketa River	290	New York City, Aquarium	*1,000,000
Yellow River, Mississippi River	a 100	Perch Hole, St. Lawrence River	†2,000,000
Kentucky:		North Carolina:	
Frankfort, State fish commission	†100,000	Highlands, Hawkins Pond	50
Louisville, Ohio River	†180,000	Roseboro, Baggett's pond	50
Mount Sterling, Graves's pond	125	Ohio:	
South Park, South Park Lake	†100,000	Apple Creek, Fountain Valley Pond	100
Vine Grove, Weymouth Lake	375	Isle St. George, Lake Erie	†6,000,000
Maryland:		Kelleys Island, Lake Erie	†6,000,000
Aberdeen, Glenburnie Pond	200		
Accokeek, Potomac River	†19,209,940		

a Rescued from overflowed lands and restored to original waters.
b Exclusive of 1,150,000 fry lost in transit.

TOTAL DISTRIBUTION OF FISH AND FISH EGGS, BY SPECIES, FISCAL YEAR 1919—Continued.

YELLOW PERCH—Continued.

Disposition.	Number.
Oklahoma: Sentinel, Spring Lake	50
Pennsylvania:	
Arcola, Perkiomen Creek	90
Canton, Lake Nepahwin	100
Everett, Juniata River, Raystown Branch	200
Gratersford, Perkiomen Creek	90
Harrisburg, Wildwood Lake	100
Landisville, Chickies Creek	300
Lititz, Hubers Pond	200
Mance, Berkely Pond	200
Walker Lake	200
Oaks, Perkiomen Creek	90
Phoenixville, French Creek	300
Pottstown, McFarland Sheep Farm Pond	150
Powys, Lycoming Creek	100
Schwenksville, Perkiomen Creek	90
Slatington, Cartright Pond	40
Meadow Brook Pond	40
Spring Mount, Perkiomen Creek	90
Troy, Mountain Lake	150
Valley Forge, Schuylkill River	150
Tennessee:	
Nashville, Buell's pond	250
Springfield, Murphy's pond	125
Vermont:	
Miles Pond, Miles Pond	†700,000
St. Johnsbury, Shadow Lake	†300,000
West Danville, Joes Pond	†1,000,000
Virginia:	
Boydton, Sydnor Old Mill Pond	54
Byllesby, Meadow Creek	300
Dogue Creek, Potomac River	†38,419,870
Edinburg, Forest Service	200
Emporia, Jones Pond	30
Taylor's pond	30
Little Hunting Creek, Potomac River	†9,604,970
Pohick Creek, Potomac River	†38,419,870
Wytheville, Reed Creek	600
Reed Creek, South Fork	300
West Virginia:	
Berkeley Springs, Sleepy Creek	400
Clarksburg, Davisson Run	400
Wisconsin:	
Blair, Trempealeau River	750
Trempealeau River Pond	750
Galesville, Lake Marinuka	1,250
La Crosse, Mississippi River	a 76,260
Rice Lake, Rice Lake	185
Total b	*22,660,000 †179,289,500 2,353,800

WHITE PERCH.

Disposition.	Number.
North Carolina: Edenton, Albemarle Sound	†2,035,000

WHITE BASS.

Disposition.	Number.
Arkansas: Black Rock, Black River	a 560
Illinois:	
Galena, Mississippi River	a 1,256
New Boston, Mississippi River	a 225
Sand Prairie, Mississippi River	a 500
Iowa: Bellevue, Mississippi River	a 2,574
Kentucky: East Cairo, Ohio River	a 1,000
Minnesota:	
Homer, Mississippi River	a 1,500
Red Wing, Mississippi River	a 250
Wisconsin: Clayton, Mississippi River	a 1,000
Total	8,865

YELLOW BASS.

Disposition.	Number.
Mississippi: Meridian, Waterworks Lake	600

STRIPED BASS.

Disposition.	Number.
North Carolina: Weldon, Roanoke River	†13,540,000

a Rescued from overflowed lands and restored to original waters.
b Exclusive of 750 fingerlings lost in transit.

Total Distribution of Fish and Fish Eggs, by Species, Fiscal Year 1919—Continued.

MACKEREL.

Disposition.	Number.	Disposition.	Number.
Massachusetts:		Massachusetts—Continued.	
Falmouth, Buzzards Bay	† 7,179,000	Woods Hole, Vineyard Sound	† 215,000
Gosnold, Buzzards Bays	† 2,114,000	Total	† 9,508,000

COD.

Maine: Boothbay Harbor, Boothbay Harbor	† 1,067,000	Massachusetts—Continued.	
Massachusetts:		Lackeys Bay, Vineyard Sound	† 1,507,000
Beverly, Massachusetts Bay	† 20,550,000	Naushon Island, Vineyard Sound	† 1,370,000
Gloucester, Atlantic Ocean	† 7,230,000 *243,870,000	Rockport, Ipswich Bay	† 15,100,000
Great Harbor, Vineyard Sound	† 10,644,000	Woods Hole, Eel Pond	† 4,729,000
Jobs Neck, Vineyard Sound	† 2,134,000	Total [a]	† 64,331,000 *243,870,000

POLLOCK.

Maine: Boothbay Harbor, Boothbay Harbor	† 1,714,000	Massachusetts—Continued.	
Massachusetts:		Marblehead, Massachusetts Bay	† 17,520,000
Beverly, Massachusetts Bay	† 69,340,000	Rockport, Atlantic Ocean	† 207,120,000
Gloucester, Atlantic Ocean	† 309,098,000	Ipswich Bay	† 36,180,000
Ipswich Bay	† 15,000,000	Total	† 703,972,000
Manchester, Massachusetts Bay	† 48,000,000		

HADDOCK.

Maine: Boothbay Harbor, Boothbay Harbor	†192,000	Massachusetts—Continued.	
Massachusetts:		Rockport, Atlantic Ocean	† 7,830,000
Beverly, Massachusetts Bay	† 22,120,000	Ipswich Bay	† 21,830,000
Gloucester, Atlantic Ocean	† 58,350,000 *200,390,000	Total [a]	† 129,592,000 *200,390,000
Marblehead, Massachusetts Bay	† 19,270,000		

WINTER FLOUNDER.

Maine:		Massachusetts—Continued.	
Boothbay Harbor, Boothbay Harbor	†12,893,000	Waquoit Bay	†229,702,000
Linskins Bay	†470,441,000	Gloucester, Annisquam River	†7,710,000
Lobster Cove	†67,303,000	Gloucester Harbor	†75,320,000
Mill Cove	†58,269,000	Ipswich Bay	†17,880,000
Townsend Gut	†64,278,000	Gosnold, Hadley Harbor	†109,978,000
Bristol, Robinson Cove	†24,196,000	Lackeys Bay	†110,871,000
Cundy Harbor, Hen Cove	†79,402,000	Manchester, Massachusetts Bay	†12,150,000
Piddley Cove	†68,059,000	Provincetown, Provincetown Harbor	†30,144,000
East Boothbay, Linekins Bay	†78,633,000	Rockport, Atlantic Ocean	†4,640,000
Pemaquid, Johns River	†87,004,000	Vineyard Haven, Lagoon Pond	†64,118,000
Pemaquid Harbor	†75,621,000	Woods Hole, Eel Pond	†56,551,000
Rockland, Rockland Harbor	†54,775,000	Great Harbor	†50,410,000
Southport, Ebencook Harbor	†22,686,000	Little Harbor	†74,516,000
Thomaston, Seal Harbor	†115,696,000	New York: Edgemere, Jamaica Bay	†64,966,000
Massachusetts:		Rhode Island: Wickford, Wickford Harbor	†116,920,000
Beverly, Massachusetts Bay	†21,290,000		
Chilmark, Menemsha Pond	†118,687,000		
Falmouth, Falmouth Harbor	†34,916,000		
Quissett Harbor	†174,167,000	Total	2,654,192,000

[a] The eggs were taken, fertilized, and planted on spawning grounds.

Total Distribution of Fish and Fish Eggs, by Species, Fiscal Year 1919—Continued.

MISCELLANEOUS FISHES.

Disposition.	Number.
Arkansas: Black Rock, Black River	[a] 655
Illinois:	
Aquauka, Mississippi River	[a] 95
Galena, Mississippi River	[a] 36,550
New Boston, Mississippi River	[a] 1,915
Iowa:	
Bellevue, Mississippi River	[a] 40,570
Fairport, Mississippi River	[a] 1,455
Harpers Ferry, Mississippi River	[a] 44,000
McDolons Dam, Mississippi River	[a] 20,000
Manchester, Maquoketa River	85
Smiths Ferry, Mississippi River	[a] 11,900
Yellow River, Mississippi River	[a] 66,000
Maryland: Baltimore, State fish commission	†1,000,000
Minnesota:	
Homer, Mississippi River	[a] 70,400
Red Wing, Mississippi River	[a] 3,025
Wisconsin:	
Clayton, Mississippi River	[a] 70,000
La Crosse, Mississippi River	[a] 352,600
Lynxville, Mississippi River	[a] 8,000
Prairie du Chien, Mississippi River	[a] 20,000
Total	747,250 †1,000,000

LOBSTER.

Disposition.	Number.
Maine:	
Boothbay Harbor, Harpswell Harbor	†2,000,000
Hodgdon Cove	†1,000,000
Johnson Cove	†1,000,000
Maine—Continued.	
Pemaquid Harbor, Johns Bay	†2,000,000
Southport, Ebencook Harbor	†1,500,000
Total	†7,500,000

[a] Rescued from overflowed lands and restored to original waters.

ARTIFICIAL PROPAGATION OF THE SALMONS OF THE PACIFIC COAST

REVISED AND ENLARGED BY

HENRY O'MALLEY

Field Assistant, U. S. Bureau of Fisheries, In charge of operations on the Pacific coast

Appendix II to the Report of the U. S. Commissioner of Fisheries for 1919

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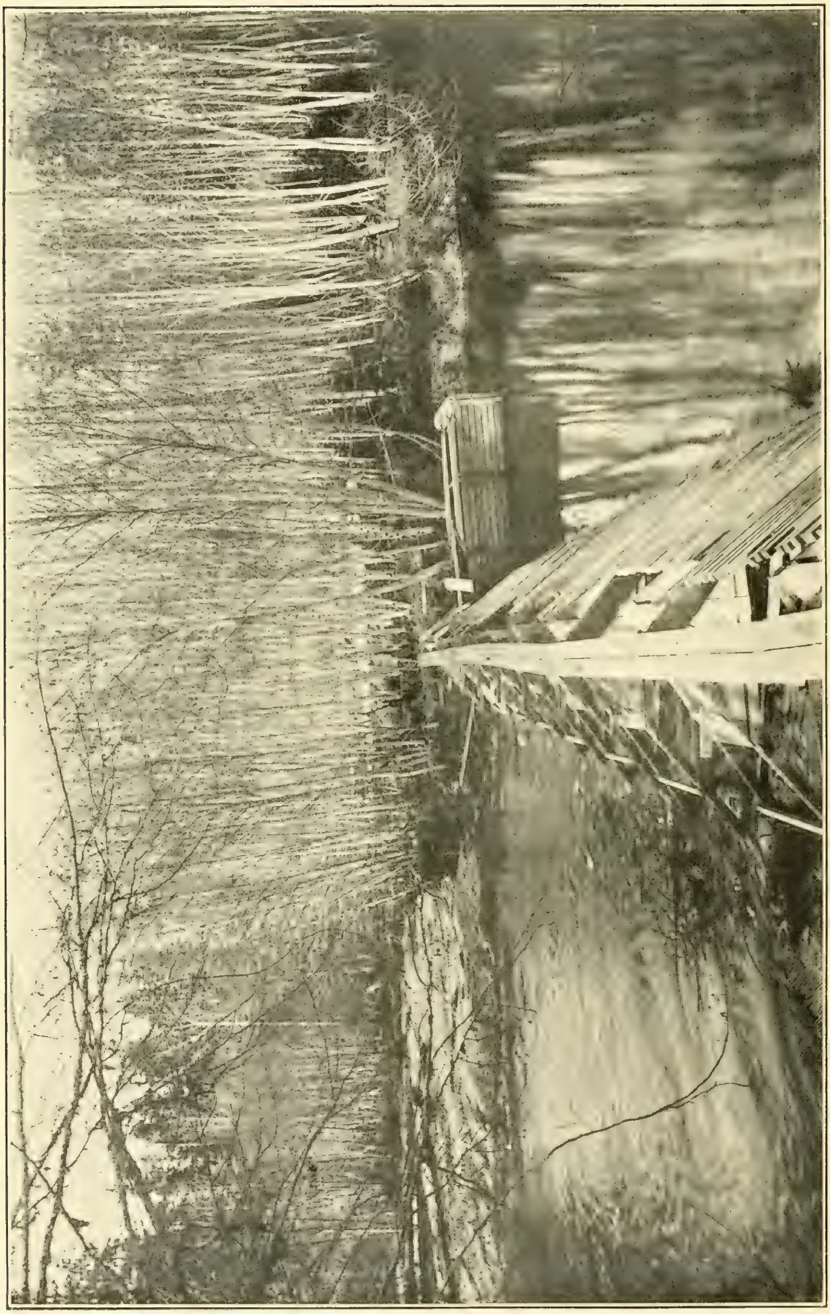


RACK WITH UPSTREAM TRAP, DUCKABUSH RIVER, WASH.

ARTIFICIAL PROPAGATION OF THE SALMONS OF THE PACIFIC COAST.[a]

Revised and enlarged by HENRY O'MALLEY, *Field Assistant, U. S. Bureau of Fisheries, in Charge of Operations on the Pacific Coast.*

THE SALMONS OF THE PACIFIC COAST.

There are five species of salmon on the Pacific coast belonging to the genus Oncorhynchus, namely, the chinook, spring, king, or quinnat salmon (*Oncorhynchus tschawytscha*); the blueback, sockeye, or redfish (*Oncorhynchus nerka*); the humpback or pink salmon (*Oncorhynchus gorbuscha*); the silver or coho salmon (*Oncorhynchus kisutch*); and the chum or dog salmon (*Oncorhynchus keta*). Among the features which distinguish the Pacific salmons from the Atlantic salmon are the larger number of rays in the anal fin and the invariable habit of spawning but once and then dying; the Atlantic salmon may spawn several times.

The characters noted in the following key will usually be sufficient to distinguish the different species of Pacific salmon:

Chinook salmon.—Scales in longitudinal series, about 135; pyloric cœca, 110 to 200, averaging 150; gillrakers comparatively short, from 20 to 25 in number, 9 being above the angle; rays in anal fin from 14 to 19, average 16; branchiostegals, 14 to 19, average 16. Body robust; head conic; caudal fin lunate. Color above dusky, sometimes with bluish or greenish tinge; sides and belly silvery; head dark, with metallic luster, back and sides with prominent spots, usually X-shaped.

Blueback salmon.—Scales in longitudinal series, about 130; pyloric cœca, 75 to 100; gillrakers comparatively long and slender, from 30 to 40 in number; rays in anal fin, 14 to 18; branchiostegals. 13 to 15. Body rather slender; caudal fin lunate; anal and dorsal fins low. Color, sides silvery, no spots on back, which is frequently bright blue.

Humpback salmon.—Scales very small, 200 or more in longitudinal series; pyloric cœca very slender, about 180 in number; gillrakers short, from 20 to 25; anal rays, 15; branchiostegals, 11 to 12. Color, bluish above, silvery on sides; lower part of back, adipose fin, and tail with numerous black spots, largest and of oblong form on tail.

Silver salmon.—Scales large, about 130 in longitudinal series; pyloric cœca comparatively few and large, 40 to 110 in number,

[a] This paper represents a revision and enlargement of the chapter on "The Salmons of the Pacific Coast," from the Manual of Fish-Culture, published in the Report of the U. S. Commission of Fish and Fisheries for 1897, a first revised edition of which was published separately in 1900. The chapter was subsequently issued in separate form under the title "Artificial Propagation of the Salmons of the Pacific Coast."

average 70; gillrakers long and slender, 20 to 25 in number; anal rays, 11 to 15, average 13; branchiostegals, 12 to 14. Body long; head short, conic; snout blunt; eye small; fins small, caudal deeply lunate. Color, bluish green, sides silvery, finely punctulated, as in the chinook, but not so conspicuous.

Chum salmon.—Scales of medium size, about 150 in lateral line; pyloric cœca, 140 to 185; gillrakers from 20 to 25; 13 or 14 rays in anal fin; branchiostegals, 13 or 14. Form of chinook, but head longer and more depressed. Dusky above and on head; paler on sides; very fine spots on back and sides, often wanting; tail deeply lunate, plain dusky or finely spotted, with black edge; other fins blackish.

These salmons are the most important group of fishes entering the rivers of North America. The steelhead (*Salmo gairdneri*), popularly regarded as a salmon, also inhabits the waters of the Pacific coast and adds to the importance of the salmon tribe.

In recent years the annual catch of salmon in the Pacific Coast States, British Columbia, and Alaska has been approximately 585,000,000 pounds, with a value, as placed on the market, of nearly $40,000,000. In 1918 the quantity of salmon canned was 7,829,212 cases of forty-eight 1-pound cans.

CHINOOK SALMON.

The chinook salmon (*Oncorhynchus tschawytscha*) is also known by other names than those given above, as Columbia, Sacramento, and tyee salmon. It is one of the most important of the salmons, being superior in food qualities and attaining a vastly larger size than any of the others. When fresh from the ocean, it is a very handsome, resplendent, well-formed fish. The flesh is of a rich red color in the greater number of individuals, but all runs contain a smaller or larger percentage of fish having white meat. Buyers cut into the shoulder of the fish for arriving at the color. The white meat is equally as good as the red as a food, but the rich red fish have the greater market value, both in the fresh condition and for canning.

No other salmon in the world compares in size with the chinook. In the Yukon River, Alaska, it occasionally attains a weight of over 100 pounds; and in the Columbia River there have been well-authenticated cases of specimens weighing over 80 pounds. Farther south the size is smaller, although in the Sacramento River individuals from 50 to 60 pounds in weight are not rare. In the Columbia 20 pounds is a fair average, and in the Sacramento about 16 pounds.

The known range of the chinook in American waters is practically from Monterey Bay (latitude 36½°) to the Yukon River, but individuals have been seen in Norton Sound, somewhat north of the Yukon, and as far down the coast of California as the Santa Barbara Channel. However, it is not known to spawn naturally in any stream south of the Sacramento River. It extends across Bering Sea to Kamchatka and south to Hokkaido, Japan.

Fish of this species prefer the larger rivers, like the Sacramento, Columbia, Skagit, Nushagak, and Yukon, and they are very persistent in making the ascent. The summer and later runs seek spawning grounds not far from the ocean, but the first or early

spring runs ascend to extreme headwaters. They have been seen crowding up rivulets forming the headwaters of the Sacramento and Columbia Rivers with nearly half their bodies exposed above water. No matter how far the headwaters are from the ocean, some of the run will proceed till forced to yield to an impassable obstruction. On reaching their goal the early fish remain several weeks in deep, quiet holes before going on the spawning grounds. The rate of ascent varies with climatic conditions, the season, and the condition of the rivers, which are affected by melting snow during the spring and summer and by rains in the fall months. They proceed very slowly at low-water stage, sometimes lying for weeks or months in deep pools, and rapidly when the water is at a moderate stage; but at extreme high or flood stage they remain quiet until the water begins to fall and clears, when they resume their journey.

When they first come from the ocean the sexes are very similar in appearance, but as the time for spawning approaches a difference is noted between them, becoming more pronounced as the season advances. The developing ova of the female produces a round, plump form, while the male becomes thin, his head flattening, and his upper jaw curving like a hook over the lower. His eyes sink; large, powerful, white, doglike teeth appear on both jaws; and the fish acquires a gaunt and savage appearance. From the time they reach fresh water their appetites decrease, and their throats and stomachs gradually shrink, until, at the near approach of the spawning season, they have become entirely incapacitated for food, and the desire and the ability to feed has left them entirely. The great reserve of flesh and oils brought with them from the ocean enables them to keep the vital organs active until their mission is accomplished. After reproduction they die on or near the spawning grounds. This singular fact has been disputed, but its truth has been proved conclusively and repeatedly. After they are entirely spawned out they remain on the beds, deteriorating rapidly, the flesh shading off to a light, dirty pink, and they become foul, diseased, and much emaciated. Their scales are partly absorbed and, in the males, wholly enveloped in the skin, which is of a dark-olive or black hue; blotches of fungus appear on their heads and bodies; and in various places there are long, white patches where the skin has been partly worn off. Their tails and fins become badly mutilated, and in a short time the fish die.

They are found feeding in Monterey Bay in any month of the year when food is there. On their way to the spawning beds they reach this body of water about the second week in January and may be caught with hook and line. In February they may be observed in numbers in the Sacramento River. In the Columbia River they appear in March but are not abundant until April or May. They arrive in southern Alaska in May and farther north in June, while it is probably still later before they ascend the Yukon, where the running season is short and may not exceed a month or six weeks. The early runs in the Columbia River are usually from one to three weeks in passing from the mouth of the river to Clifton, a distance of about 20 miles. They first arrive at The Dalles, 200 miles up the river, in the middle of April, and are found in numbers at this point about the middle of June, two months after appearing in larger numbers at the river bay, thus covering a distance of about

100 miles a month. As the season advances the rate of progress up the rivers is more rapid.

The spawning season varies in different rivers and covers a period of at least four months. The spring run begins to spawn at the headwaters of the Willamette and Salmon Rivers, tributaries of the Columbia, in August, while the summer run at the Little White Salmon and Big White Salmon stations, nearer the ocean, begins spawning about September 20. At the Clackamas (Oreg.) station, eggs are secured from the fall run from the last of September to about December 1.

For the deposition of their eggs chinook salmon invariably seek a shallow, gravelly riffle, where the water is a foot or more deep, and the current sufficiently swift to carry and spread the eggs and milt. There is no doubt that in many instances the so-called nest, which is an elongated cavity or depression, often several feet across and 12 or more inches in depth, is started by either the male or female in advance of actual spawning, but as a general thing it is formed by the fish in the act of spawning. At this time both the male and female turn on their sides and by contraction of the abdominal muscles, which produces a quivery motion of the body, effect the simultaneous emission of milt and eggs. At about the same time a forceful movement of the tail and posterior part of the body serves to loosen the gravel and propel the fin forward more or less, thus, by frequent repetition, enlarging the depression and covering the eggs with the loose gravel. It seems evident that this is nature's provision for the protection of the eggs, during the incubation period. With every effort made by the fish in the extrusion of the eggs and milt the depth of the covering is increased, and this serves not only to screen them from the light, which is conducive to the growth of fungus, but also protects them from the prying eyes of trout and other active aquatic enemies.

The length of time consumed in spawning is largely governed by the number of eggs a female contains and also by the temperature of the water. In some instances all of the eggs will be deposited within a day or two, while in others spawning will extend over a period of a week or 10 days.

Both the eggs and the fry are subject to destruction by freshets washing them out of the gravel or covering them so deep that, if they are not actually killed by the pressure on them, it becomes impossible for the fry to work their way out. In many streams spawning occurs during high-water stages in the fall, the eggs in numerous instances being deposited in gravel which is entirely above the water later in the season. Many eggs are lost also by trout lying close in behind the salmon and catching them as they are emitted. Some are rooted out of the nest, and the natural enemies take their toll as the fry emerge from the gravel. It is the instinct of the fry to lie quiescent until the umbilical sacs have been absorbed, when they leave the nest in search of food.

Experiments conducted some years ago by John P. Babcock [a] have demonstrated clearly that only those eggs in natural spawning which are embedded beneath from 5 to 6 inches of sand and gravel produce

[a] Some experiments in the burial of salmon eggs, suggesting a new method of hatching salmon and trout. Transactions, American Fisheries Society for 1910, pp. 393–395, Washington, 1911.

FIG 1.—CHINOOK SALMON. BREEDING MALE.

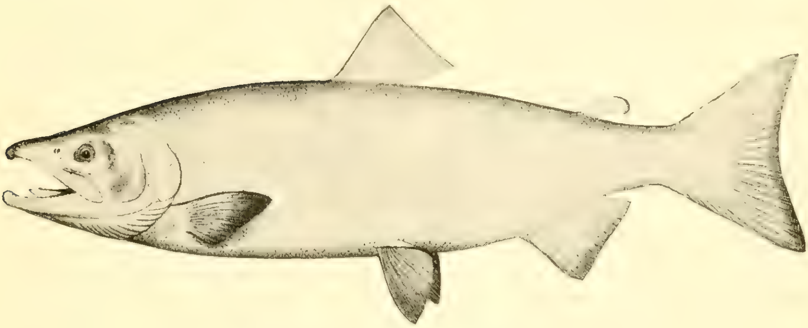


FIG. 2.—BLUEBACK SALMON. ADULT MALE.

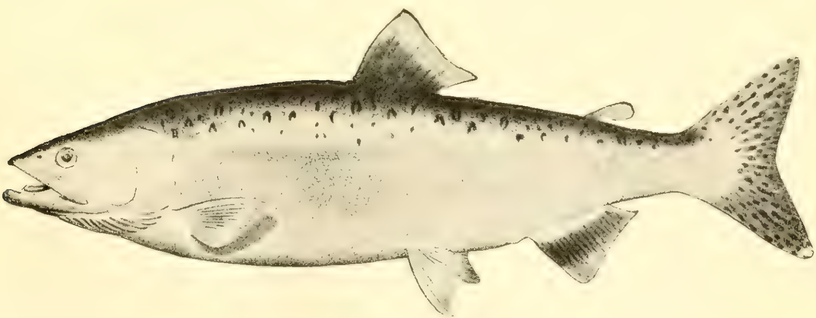


FIG. 3.—HUMPBACK SALMON. ADULT MALE.

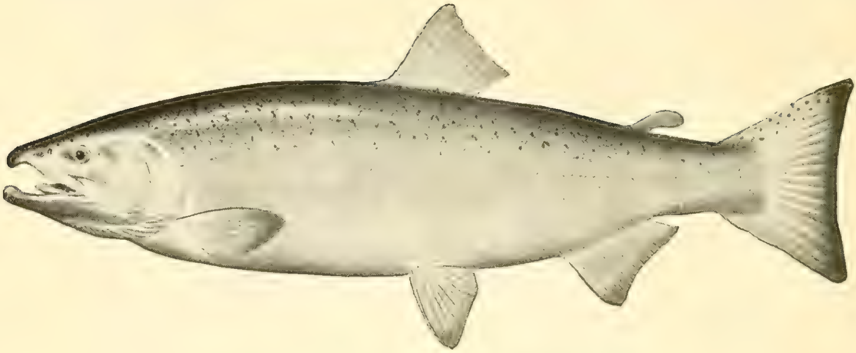


FIG. 1.—SILVER SALMON. BREEDING MALE.

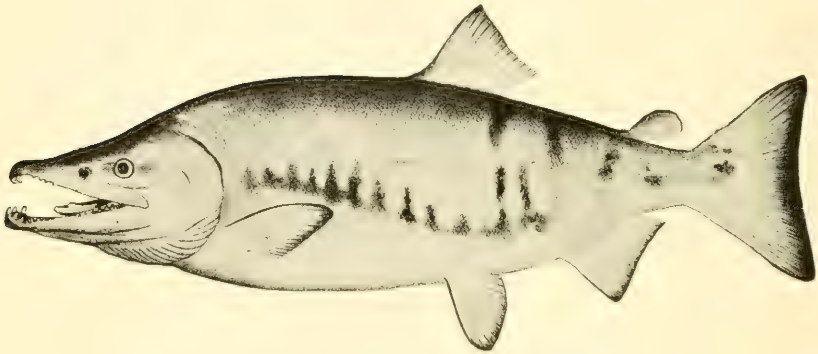


FIG. 2.—CHUM SALMON. BREEDING MALE.

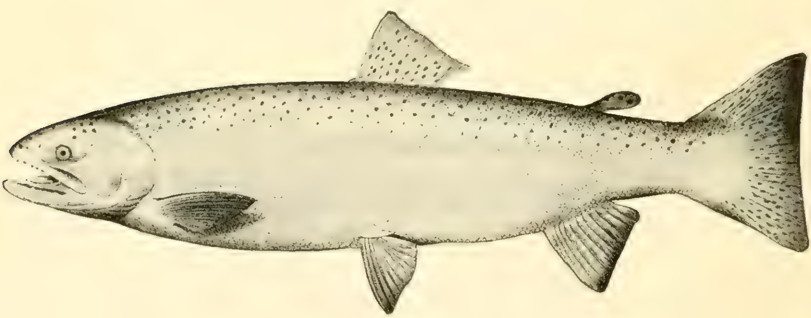


FIG. 3.—STEELHEAD.

alevins that live to attain the fry stage, and that the eggs not so covered are either consumed by active natural enemies or are destroyed by the vegetable mold known as fungus. The experiments have shown that the burial of freshly fertilized eggs of Pacific salmon in sand or gravel to the depth stated does not smother them, but that eggs so treated will hatch, and the resulting alevins will possess the instinct and power to work their way gradually to the surface after the disappearance of the food sacs, at which stage of development they are not attacked by fungus. Eggs buried under from 2 to 3 inches of gravel were found to produce alevins coming to the surface before the sacs had been absorbed, and they were therefore subject to fungus, a very large percentage of them being destroyed in that way, as well as by the more-developed forms of aquatic life. The sacs of fry resulting from eggs buried less than 4 inches deep are so thinly covered when they reach the surface that few, if any, of the fish survive the effects of fungoid growths, and, as such growths are very common in the beds of streams where large numbers of salmon have spawned and died, it follows that very heavy losses of eggs must occur on eggs naturally deposited.

The yield of eggs from the chinook salmon will average from 3,000 to 6,000 per fish. The eggs are of a deep, salmon-red color, measuring about one-fourth of an inch in diameter, and are heavier than water.

In view of the enormous annual catch of this salmon for commercial purposes, the necessity for its propagation became manifest at an early period in the history of the Pacific fisheries. Fortunately, it is readily susceptible of artificial production on a large scale; otherwise the supply in western rivers would by this time have materially fallen off. Since the work began in 1873 on the McCloud River it has grown to larger proportions. It now engages the attention of all the coast State governments, as well as that of the Federal Government, and the work is steadily growing in importance.

As the salmon ascend the rivers they are caught by gill nets, fyke nets, pounds, weirs, seines, wheels, and other devices, but in the Sacramento and Columbia Rivers the greater numbers are caught as they head upstream with gill nets drifting with the current or tide. In the rivers they are comparatively safe from enemies, but immense numbers are destroyed at the mouths of the streams by seals and sea lions.

This species has been introduced into Australia, New Zealand, and Europe, but so far as is known New Zealand is the only country where its acclimatization has been effected. Efforts have been made to establish it in Atlantic streams of the United States, but without permanent results. In some of the fresh-water lakes of New England the chinook salmon has been introduced purely for angling purposes. In such instances permanent fisheries can not be expected save by restocking.

BLUEBACK SALMON.

This species (*Oncorhynchus nerka*) is known in different regions under the names of blueback, redfish, Fraser River salmon, and sockeye. It ranks first of the salmon in commercial value, being es-

pecially important in the Fraser River and in Alaska. The color of the flesh is a rich red, which persists after canning. Large quantities are canned on Puget Sound, in British Columbia, and in Alaska, and its commercial value to that territory is indicated by the fact that during the calendar year 1916 the total pack on the Pacific coast amounted to 2,432,048 cases. Of this total 2,119,442 cases were put up in Alaska, at a valuation of $13,147,994. Comparatively few red salmon are sold fresh in the United States.

It is next to the smallest of the salmons, the maximum weight being 12 pounds, but it seldom attains a weight of over 6 pounds in any instance.[a]

It ranges from Columbia River, Wash., to the far north. In general it ascends only such rivers as rise in glacial and snow-fed lakes. Practically nothing is known of its ocean life. Straggling specimens occur in the Quinault River late in December. It ascends the Columbia River in June and July, and at Kodiak Island it comes in numbers in June. There the heaviest run is in June and July, spawning occurring in August and September. In the Fraser River the largest runs enter during July and August, and in the watershed of this river spawning occurs from late October to the end of December, being at its maximum during November. Quinault and Baker Lakes, together with their tributaries, may be considered typical spawning grounds for this fish in the United States, and in those regions the spawning season extends from early September to late December.

The individuals of this species enter only such streams as have lakes at their headwaters, usually reaching the vicinity of the latter several weeks in advance of spawning time. Many of them deposit their eggs along the lake shores in depths of from 1 to 12 feet of water. Others ascend the creeks or rivers flowing into the lakes and spawn on the riffles in a way similar to that of the chinook salmon. The average number of eggs per fish ranges from 2,500 to 3,000. Except in the breeding season, the color is a clear, bright blue above, with silvery sides and belly. At spawning time the body becomes blood red and the head light green. The male loses his symmetrical form and develops an extravagantly hooked jaw.

HUMPBACK SALMON.

The humpback salmon (*Oncorhynchus gorbuscha*) is the smallest of the Pacific salmons, its average weight being only 5 pounds and its maximum rarely 9. Its range is from Puget Sound northward, probably as far as the Mackenzie River, and it is also common on the Asiatic coast. The southernmost spawning record is in the San Lorenzo River at Santa Cruz, Calif. In Alaska it is the most abundant and generally distributed of the salmons, and in that region there is an annual run of the species. In Puget Sound waters, however, it makes its appearance in numbers only in alternate years. No satisfactory explanation as to the cause of this phenomenon has been

[a] So-called landlocked forms occurring in various lakes weigh only one-half pound when mature. They are commonly referred to as little redfish and have long been regarded as merely dwarfed forms of the anadromous species. At one time they were believed to ascend also from the sea; later it was conclusively proved that they are permanent residents of fresh water, and there is strong evidence that they constitute one or more distinct species.

given. During the fall of 1916, which is known as the off season in Puget Sound, 1,887 cases were packed. This shows a healthful increase over the seasons previous to the Bureau's attempting the establishment of an annual run in this region.

In nutritive value the fresh-run humpback is scarcely inferior to any other salmon. While the flesh has a very fine flavor, it is paler than that of the chinook or blueback salmon, and it loses its color when canned. The total amount of this species canned during the calendar year 1916 was 2,036,077 cases, of which amount 1,753,546 cases, valued at $6,446,168, were packed in Alaska.

The humpback salmon usually seeks the smaller streams for reproduction, depositing its eggs a short distance from the sea, sometimes within a few rods of the ocean. At Kodiak Island, Alaska, where it is often very abundant, it arrives in the latter part of July, the run continuing only a few weeks. Spawning occurs in August. The eggs, of which there are about 2,000 per fish, are smaller than those of the chinook, but larger than those of the blueback and paler than either.

Shortly after its arrival from the ocean, and with the approach of the spawning season, it develops on its back a prominent hump, which, with the distortion of the jaw, gives the fish a very singular appearance. As is the case with the other salmons, it dies on the spawning bed or after being swept to sea by the current.

SILVER SALMON.

The silver salmon (*Oncorhynchus kisutch*) is also known as silversides and coho salmon. It is a beautiful fish, having a graceful form and a bright, silvery skin. Its flesh is usually of a bright-red color; but, as this fades on cooking, it is less highly regarded for canning, though large quantities are thus utilized on the Columbia River, Puget Sound, and the short coastal streams of Oregon and Washington.

In 1916 the total pack was 715,815 cases, of which 265,184 were put up in Alaska. Its range is from Monterey Bay to northern Alaska, and as far south on the Asiatic coast as Japan. It ascends the rivers to spawn in the fall and early winter, when the waters are high. In most of the rivers which it frequents there appear to be two well-defined runs, the early run ascending to the headwaters, while the later run is found in the streams nearer the ocean. The early run is composed of small-sized specimens. In Alaska the average weight of this salmon is nearly 15 pounds, and in the streams farther south about 8 pounds. It rarely attains a weight of 30 pounds. The average egg production per fish is about 3,500.

CHUM SALMON.

The chum salmon (*Oncorhynchus keta*) is the least valuable of the Pacific salmons, although it is canned and dried in large quantities on the Pacific coast and in Alaska. Its average weight is 10 pounds, and the maximum is about 20 pounds. It is found from the Columbia River northward, being especially abundant in Alaska. It is taken occasionally in the Sacramento River. When just from the ocean, the flesh is of a very pale red color. At that time it is a very

good fish, but it deteriorates rapidly in fresh water, and it loses its color in the can. It spawns in shallow riffles and creeks, usually at no great distance from the ocean. Large quantities are packed in Oregon, Washington, and Alaska. The production of canned chum salmon in 1916 amounted to 1,500,332 cases, of which 715,238 cases were put up in Alaska.

STEELHEAD.

Another anadromous fish found in Pacific coast waters is the steelhead (*Salmo gairdneri*), commonly known as steelhead and steelhead trout, and in many instances erroneously classed with the Pacific salmon in the State laws. It resembles in form, size, and somewhat in general appearance the salmon of the Atlantic coast, but is distinguished from the Pacific salmons by its short anal fin of not over 12, and usually 9 or 10, rays, square tail, small head, rounded snout, comparatively slender form, light-colored flesh, and its spring-spawning habit. Its average weight in the Columbia is about 12 pounds, but specimens weighing 42 pounds have been found in the Skagit River.

Its range is very extended, reaching from Santa Barbara on the southern coast of California to the Alaskan Peninsula, and perhaps to the Arctic Ocean. It is found in almost all the streams of the Pacific States which empty into the ocean. The only run of this species of commercial importance in the Columbia River begins in late June and is in full force in July and early August. It reaches Seufert, Oreg., about the close of the blueback run, and some of the fishing wheels catch practically nothing else. This fish feeds while in fresh water, and does not always die after spawning, but it deteriorates from the time it enters fresh water until the following spring, and spawns between the months of February and May. Its movements in other rivers on the coast are not materially different, except that it enters the southern rivers earlier and the northern rivers later than it enters the Columbia. Like the chinook salmon, the steelhead ascends for long distances, and it has been found as far up tributaries of the Columbia as the ascent of fish is possible. The number of eggs per fish ranges from 6,000 to 8,000. The greater quantities of steelhead trout are caught during the winter and spring months and are utilized in a fresh state, large quantities being shipped to eastern markets in refrigerator cars. However, during the calendar year of 1916 cases of this species to the number of 24,999 were packed.

ARTIFICIAL PROPAGATION.

Artificial propagation having been first applied on the Pacific coast to the chinook salmon, the description of methods which follow is based mainly upon the practices employed with that species. In 1916 the number of salmon and steelhead eggs collected by the Bureau of Fisheries, expressed in millions, was as follows: Chinook, 108; blueback, 105; humpback, 32; silver, 13; chum, 29; steelhead, 14. These were collected at the Afognak and Yes Bay stations in Alaska; at stations located on tributaries of Puget Sound and in the Quinault Indian Reservation, Wash.; at Clackamas and its auxiliaries in the Columbia River Basin and in southern Oregon; and

FIG. 1.—SALMON HATCHERY, AFOGNAK, ALASKA.

FIG. 2.—SALMON HATCHERY AND REARING PONDS, YES BAY, ALASKA.

FIG. 1.—ROGUE RIVER (OREG.) HATCHERY.

FIG. 2.—CLACKAMAS (OREG.) HATCHERY.

FIG. 3.—BIRDSVIEW (WASH.) HATCHERY.

at the California stations on tributaries of the Sacramento and Klamath Rivers. In addition, the private hatcheries operated by the salmon-cannery interests of Alaska, known as Fortmann, Karluk, Quadra, Hetta, and Klawak, which have been hatching blueback salmon for years, collected in 1916 over 87,000,000 eggs. The normal capacity of these five establishments is 197,000,000 eggs per annum. The Bureau's two hatcheries in Alaska have each a capacity of 72,000,000 eggs.

CONSTRUCTION OF RACKS.

The eggs found in salmon that are captured for commercial purposes are in a green state, and, therefore, in all hatchery operations of importance it has been found necessary to provide for the egg supply by installing requisite devices for the capture and retention

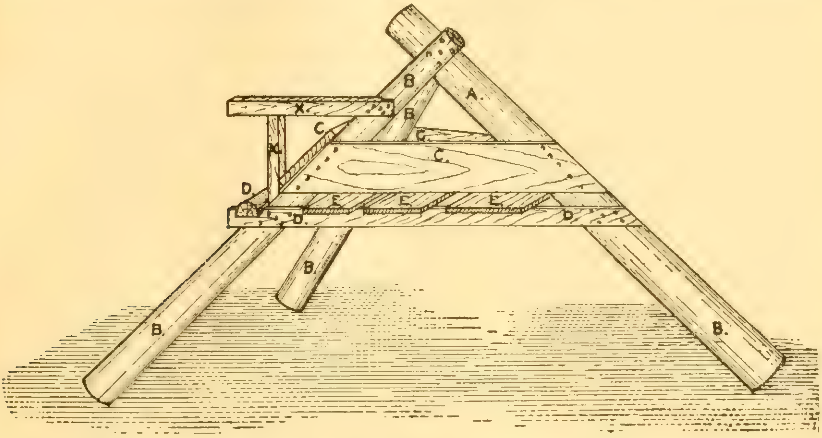


FIG. 1.—Three-legged rack horse or trestle: *A.*, horse head; *B.B.*, horse legs; *C.C.C.*, 12-inch boards to make sides of crib and also to act as braces; *D.D.D.*, leg braces which also support bottom of crib; *E.E.E.*, bottom of crib; *X.X.*, bracket for supporting walk.

of the brood fish. Such fishing is conducted at or near the spawning grounds.

The site selected for the placing of the racks should be in a good spawning locality. The upper rack is placed at the head of a riffle, and the stop or lower rack is installed just below a deep pool, the distance between the two depending upon topographical conditions. There is thus provided between the upper and lower racks a proper spawning and fishing area, with a deep pool for a resting place for the immature fish. In this inclosure the fish are held until removed for stripping. The racks are designed to control the movements of the fish regardless of the water stages, as failure to do so means the loss of a season's take of eggs.

The usual form of rack constructed in the rivers of Washington and Oregon and in most of the streams in California is built on trestles or three-legged horses, their sizes depending upon the character of the streams to be closed, and their length upon the depth of water and the angle or slope to be given the rack. The legs are made of pile timber from 8 to 12 inches in diameter. The upper leg

is longer than the other two, which are of equal dimensions, and is attached to them at an angle of 90°, the spread between the others being about 60°. The legs are braced and held in place by poles about 4 inches in diameter, which are spiked to the sides midway from the ground to where the legs are joined, and, as an extra precaution, an additional brace is nailed across the two rear legs.

The braces strengthen the bottom of the crib, which is made of 1-inch rough lumber, and the 12-inch boards composing its sides serve as an additional brace to the legs. Such a crib will hold from 100 pounds to almost a ton of rock, the amount varying with the size of the braces used and the current which it is expected to withstand.

The trestles are set from 8 to 12 feet apart directly across the stream on the site selected for the rack, the distance between each being governed by the size of the stream and the strength of rack desired. The trestles are then lined up and loaded with stones, and two stringers from 8 to 12 inches in diameter are put on and spiked to the upstream side of the forward leg. While the position of the stringers must be governed to some extent by the height of the rack, it is usual where the rack is of ordinary construction to place the upper stringer about 30 inches above the water surface and the lower one midway between that point and the river bottom. On large streams a third stringer is sometimes used to good advantage.

Where the bed of the stream is of hard formation 2 by 3 fir pickets are put down even with the bottom at intervals of 1½ inches and nailed to the stringers, the 2-inch surface being placed to the current and the upstream edge beveled in order to present the least possible resistance to the current. In streams with soft shifting bottoms it is often necessary to drive the pickets. As a further precaution against the escape of the salmon by the loosening and displacement of the pickets by the current, or by the struggling of the fish, a block 3 inches long by 1½ inches wide is nailed to each picket at a point halfway between the lower stringer and the bottom. A layer of bowlders and rock from 3 to 5 inches in diameter is then placed in front of the rack at the point of the pickets to close effectually all openings between the ends of the pickets and the river bottom; and brackets for supporting a walk are nailed to the downstream side of the trestles, thus providing a means of keeping the rack cleared of débris at all times.

In streams where shingle bolts, cordwood, and driftwood occur, a gate is provided for their passage, and the necessary sheer booms are constructed in front of the racks to guide the timbers to the opening. The gate should be built between two trestles which have been placed 8 feet apart, and the open space connected by a stringer placed below the surface of the water at a depth of at least 18 inches. Pickets are attached to this stringer in the usual manner, except that they must be sawed off even with its top, and the sides of the space are squared up and walled with 1-inch lumber.

The gate is constructed of 1 by 4 inch strips 12 or more feet long, which are placed on edge at intervals of 1½ inches, well blocked and braced. It is then hinged to the stringers in such a manner that it will swing freely. One way to accomplish this is to bore holes through the ends of the strips and insert 1-inch pipe, the ends of which, projecting a few inches on either side of the gate, allow it to

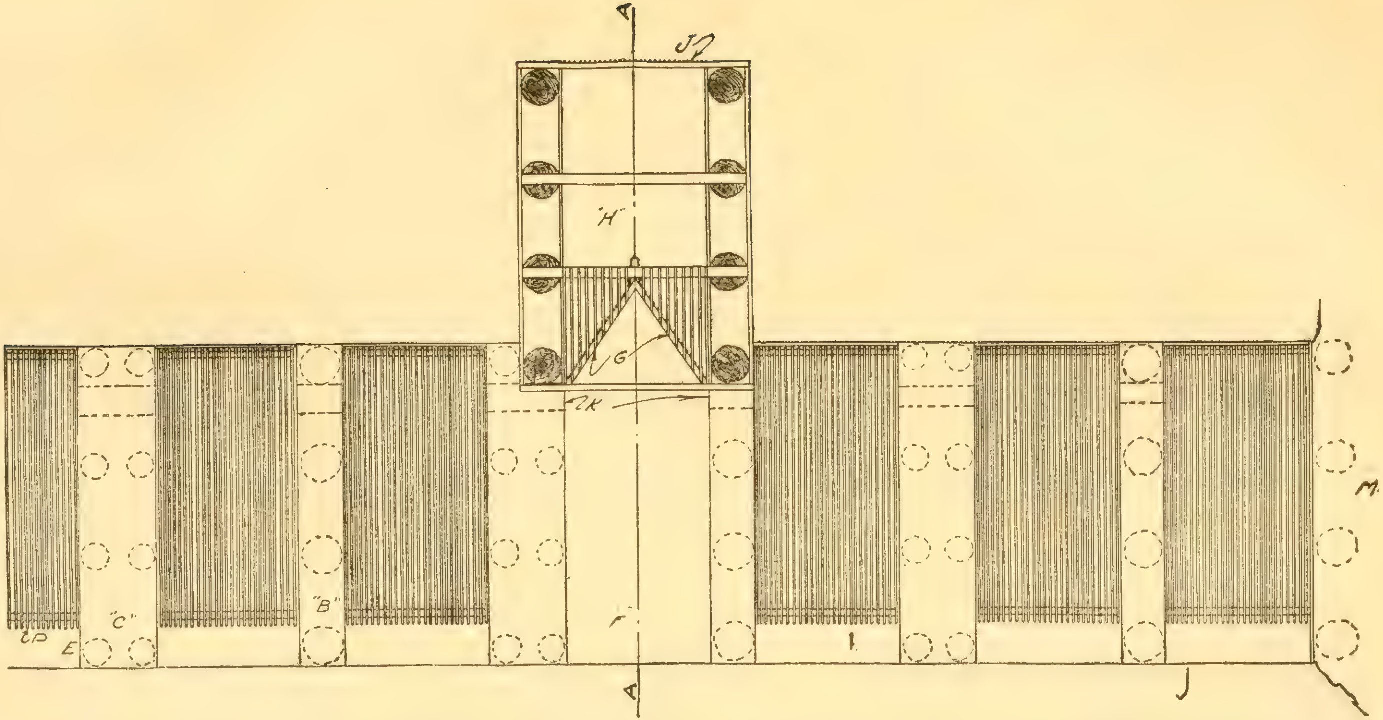


FIG. 2.—Plan of barricade in Phinney Creek, near Birdsview, Wash.: *B* and *C*, single and double rows of piles, respectively; *D*, downstream end of racks; *E*, floor under racks; *F*, open channel to trap; *G*, walls of **V**-shaped approach to trap; *H*, trap; *J*, screen at head of trap; *K*, openings in pier for passage of fish to *G*; *L* (fig. 3), door in north side of **V**-shaped approach; *M*, abutments.

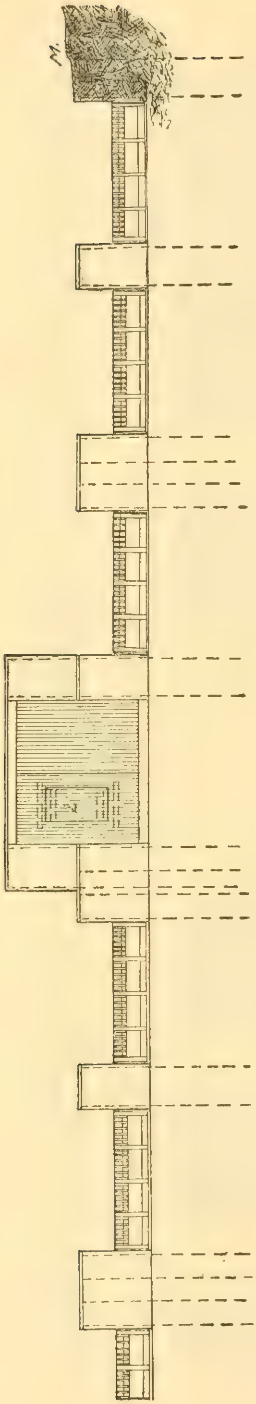


FIG. 3.—Front elevation of barricade shown in figure 2.

turn in eyebolts in the side walls. To prevent the fish passing through when the gate is open, a 12-inch board should be nailed across its under side at such an angle that the current rushing against it will lift the lower end of the gate just above the surface of the water. Floating objects coming down the stream are carried onto the gate, which sinks from their weight, and as the current carries the object on the gate closes automatically.

Racks constructed in accordance with this method will often stand submerging several times in the course of a spawning season, and at its close remain practically undamaged.

A barrier that has stood the test of several years and has proved that it will operate successfully in almost any stage of water is described in the following paragraphs.[a] The design is to be credited to A. H. Dinsmore, former superintendent of the Baker Lake (Wash.) station.

A permanent barrier at the Birdsview station, an auxiliary of the Baker Lake station in Washington, is of novel construction and calls for more than passing notice. This barrier is located in a portion of Phinney Creek, where formerly there was a dam built for the purpose of obstructing the passage of steelhead trout. When the dam washed out, a new channel formed and the river bed was very much broadened.

The first step in the construction of the new barrier was the laying of four heavy log stringers across this new channel from the abutment on the north to the new bank on the south side of the stream. The logs were let down through the dam foundation to low-water level on the north side, and the deep channel under them on the south side was filled with brush and gravel. The logs were spotted down to form a practically level bed, reaching the width of the stream. Heavy piles were then driven behind each stringer to form alternate single and double rows extending up and down stream. The log stringers were next planked over, forming a platform 18 feet wide, similar to a regular dam apron, extending from the north abutment to the final row of piles on the south side, a distance of about 140 feet.

By planking the sides of the single row of piles and all around the double rows and filling the space with rocks, piers 4 feet high and approximately 2 feet and 4 feet wide were formed. Through each pier at the bottom, behind the upstream pile, openings 1 foot square were left,

[a] Titcomb, John W.: Fish-cultural practices in the Bureau of Fisheries. Bulletin, U. S. Bureau of Fisheries, Vol. XXVIII, for 1908, part 2, pp. 728–732. Washington, 1910.

connecting the spaces between the piers. These spaces, 12 in number, are approximately 8 feet wide and are filled by swinging gates hinged to a 3 by 12 inch timber, spiked securely to the piers on either side and forming a dam or flashboard across the space above. By the insertion of other flashboards above this one a tight dam 4 feet high can be quickly formed at any time. The utility of this feature will be explained elsewhere.

The gates are made of 1 by 4 inch fir set on edge and nailed to 2 by 4 inch joists, being strengthened by 2-inch blocks set between the rack bars and nailed to them and the joists. These blocks thus determine the width of the interstices in the gates. At the upper end of each gate an auger hole is bored through the bars and blocks, to accommodate a 2-inch iron pipe, which passes through the entire upper end of the gates. Ringbolts clasp these pipes and are fastened to the 3 by 12 inch timber forming the flashboard, acting as hinges upon which the gates swing. At the lower end of each gate a wide board, 1¼ by 16 inches, is secured by means of braces, forming an angle of 45° with the lower end of the gate.

At an ordinary stage of the stream the downstream ends of the gates rest on supports which hold them a foot or more higher than the upper ends, the water passing down through them to the floor of the apron, where it runs away. The fish working up under the gates to the dam board find the cross passages through the front end of the piers and finally reach the trap. It was expected that during freshets the current acting on the flashboard would always keep the lower ends of the gates above the surface of the water, and up to a certain

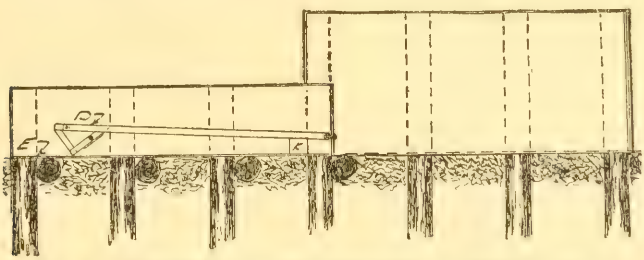


FIG. 4.—Side elevation of barricade shown in figures 2 and 3.

point this expectation was realized, but at very high stages of the stream the large quantity of gravel in the water soon clogs and sinks the gates. As the gates are only two-thirds the length of the apron, however, and rise toward the lower end, the water shoots over them with such force that it is projected some distance below the end of the apron, and fish attempting to scale the obstruction fall far short of the ends of the gates. The barrier has been watched many times when fish were jumping and when the largest drift ran clear, and none has ever been seen to pass it.

By means of the dam boards entire control of the current can be had during ordinary stages of water and any desired quantity sent to any section of the barrier. Thus a strong current can be maintained through the trap section, leading the fish to it, and when it is desired to remove the fish from the trap the water can practically all be turned to some other section of the barrier.

One of the greatest difficulties in maintaining traps in the streams in this section is due to the tremendous quantities of gravel carried in the water during freshets, a sufficient amount being frequently deposited in front of a trap at such times to change the course of the stream. With the present form of barrier no trouble is experienced from this source, the insertion of the dam boards and the opening of one space at a time quickly clearing away the accumulated gravel.

The ninth and tenth piers were continued upstream by driving three additional piles above each. The piers form the sides of the trap. Its floor is a plank bottom, similar in construction to the apron, and the front is barred by 1¾-inch pickets placed 1¾ inches apart, the fish entering by the usual upstream V of pickets. To protect the trap from high water the two piers between which it is located were carried to a height of 8 feet. When it is desired to fish the trap, the gate at its head is closed and entrance is made from below by means of a door in the north side of the V.

The upper end of the fishway of the old dam was left in place, the narrow passage between it and the new trap protecting the spaces at the south end of the barrier from the current and from drift. These spaces have been racked above and below to form commodious pens for males and unripe females. The south end of the barrier is protected by a substantial abutment.

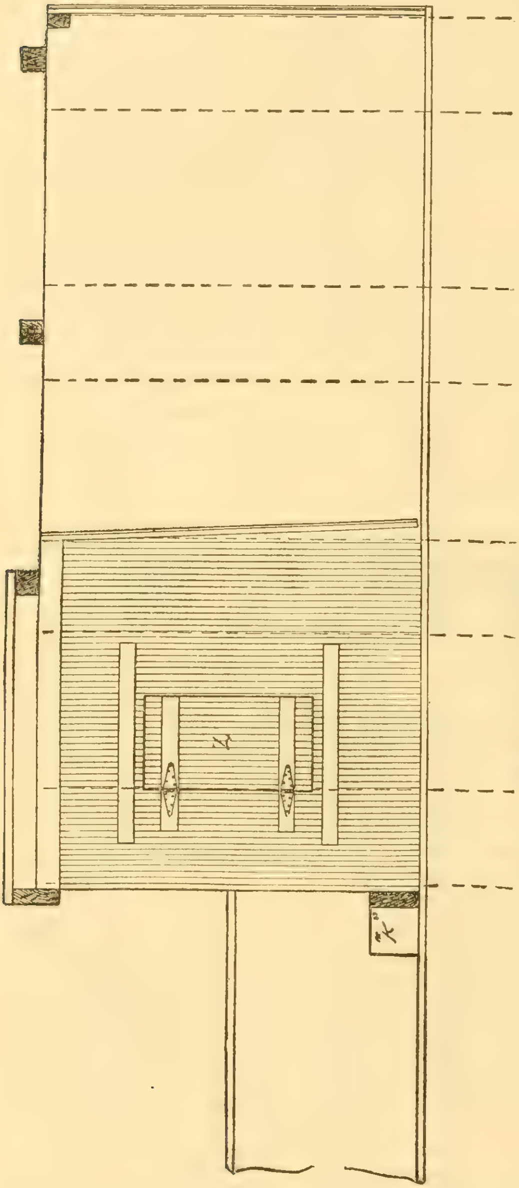


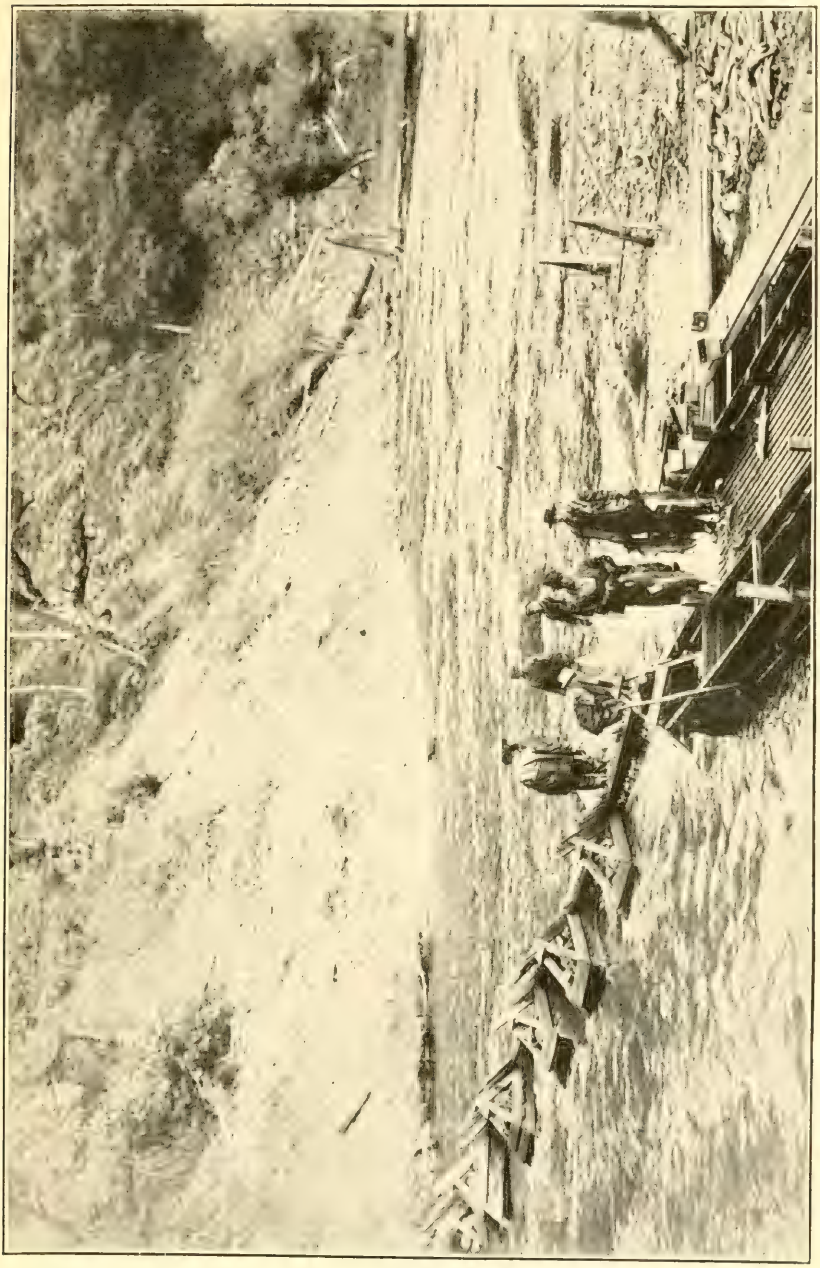
Fig. 5.—Section on line A—1 of figure 2.

The maintenance of the racks in Phinney Creek has been a very heavy item of expense in past years, and the trap was frequently carried away by freshets just at the height of the season, allowing large numbers of fish to escape and considerably reducing the season's take of eggs.

Concrete piers have been used in some of the California rivers, but they are now considered too expensive for fish-cultural work on an economical scale. In some of the streams in that State piles are substituted for trestles. These are sawed at the proper angle, capped with timbers of the right size, and used for supporting the rack stringers. In constructing racks in this way the pickets are usually placed in sections and hoisted into position by means of a derrick. Mudsills are embedded in the gravel beneath the rack and a floor placed thereon.

OBTAINING SALMON FOR PROPAGATION.

The manner of capturing the brood fish varies in accordance with the nature of the stream where the work is conducted. On some rivers the upstream trap is successfully used in connection with the head rack (Pl. 1). The tray used is sometimes a square or oblong inclosure; at other times it is a pen constructed of lumber. In either case the entrance is made on the principle of



DOWNSTREAM TRAP, LITTLE WHITE SALMON RIVER, WASH.

the ordinary pound net. In their eager efforts to pass upstream the fish go through the V-shaped mouth of the trap, and, having once entered, they seldom find their way out. The trap is usually covered to prevent the escape of the fish by jumping.

In streams where the current is strong, as in Oregon and Washington, the fish are sometimes taken on the riffles by means of gill nets; but, as many are killed or injured when so caught, this method should be employed only as a last resort.

In the comparatively slow streams of California it is customary to employ drag or sweep seines of suitable length and depth, which are operated below the head rack and above the retaining rack.

Where the natural conditions will permit, the most economical means of capturing salmon is by the use of a downstream trap. The use of this device necessitates that the upper rack be placed across the river at the head of a spawning riffle having a good fall. The wings of the trap, constructed on the same principle as the rack and with openings provided near the shore ends for the entrance of the salmon to the spawning waters below the main rack, are run downstream from one or both shores, as local conditions may require, and at their convergence the trap is located. The trap, which is usually about 5 feet wide, is made of smoothly dressed slats or poles, the small ends of which are nailed to a light sill sunk in the bed of the stream, with a space of 1½ inches between each pole, to allow the water to flow through freely. From the sill they rise in a gentle incline downstream to a level a few inches above the point where the water runs through, and they are then sprung down and nailed to sills, forming the bottom of the trap. The sides of the entrance and the trap proper are usually made of poles or pickets placed horizontally, with sufficient space between to permit water to escape freely. The sides of the entrance are well braced to withstand the pounding of the salmon when rushing into the trap in numbers, and on either side of the trap live pens for holding the ripe fish are constructed. Across its entrance a grating is placed to prevent the fish from being carried into it when not in use.

When the trap is to be fished, the openings in the lead are closed and the grating at the entrance removed. The seine is laid out at the head of the riffle, whence it is rapidly carried by the current downstream toward the trap. The fish on the riffle become frightened at the seine and run downstream. Following the converging leads and traveling rapidly with the current, they are driven into the mouth of the trap. Before they can turn, their momentum carries them high and dry onto the trap floor, where an attendant picks them up, liberates the green fish in the water below, and places the ripe males and females in their respective pens. The fish which try to turn back before reaching the trap are caught by the heavy leaded seine and held against the lead racks until the fishermen find them.

At the Big White Salmon station of the Bureau of Fisheries success has been attained by purchasing salmon from the fish-trap men and towing them in live cars to an inclosure made by racking a spring creek having a soft, sandy bottom, which is particularly adapted to the successful ripening of immature fish. The death rate of the fish while being held there to ripen is small, and the eggs taken from them are of excellent quality.

At Baker Lake the fish are taken in a web trap as they enter the lake and are impounded in a slough at the head of the lake and held there successfully for several months. When mature, they are removed from the inclosure by means of a drag seine.

Where immature salmon are to be held for any length of time, an inclosure with a soft, muddy bottom should be provided for the purpose, it having been found by experience to be far superior to a gravel bottom.

A rather novel method is employed for capturing silver salmon and steelheads where the barrier preventing the ascent of the fish chances to be a dam or a natural fall. At an advantageous point, where the water pours over the crest of the barrier and where the fish are known to jump in their attempt to ascend the river, a device known as a jumping box is installed, being placed back of the fall at a sufficient height, so that when the fish jump they will be likely to fall through the water into it. The length of this box or trough is governed by local conditions; its width varies from 18 to 24 inches, and it is given a fall of at least 12 inches to each 10 feet of length. A covered flume with a sharp fall connects it with a live box, which is placed in the stream in such a manner as to insure its protection so far as possible from high water, and at the outlet of the flume leading to the live pen a downstream V is placed. This, together with a secure cover, serves to prevent the escape of the fish from the pen.

In the operation of this contrivance the fish fall into the jumping box, and before they can regain their equilibrium they are carried into the live pen and are held there until removed. Care must be taken to prevent overcrowding in the pen, as, when the fish are jumping from 6 to 9 a. m. and from 3 in the afternoon until sundown, they are apt to be taken in such numbers that loss from smothering will result, unless the pen is emptied at frequent intervals.

TAKING AND IMPREGNATING THE EGGS.

When chinook-salmon eggs are taken on a large scale, say from a half million to three or four millions per day, as is customary at the Little White Salmon station on the Columbia River, spawning usually occurs daily throughout the egg-collecting season, it being impracticable to hold the fish in pens for any length of time, as they injure themselves more or less in fighting against confinement, and many eggs are dropped.

The females are placed in pens by experienced men, and ripe ones only are put in. Of the signs that indicate ripeness in a female salmon the separation of the eggs in the ovaries is the surest. Specific signs are all fallible, however, and the spawn taker must rely mainly on an indescribable ripe look, which is neither color, shape, nor condition of organs, but a general appearance which shows at a glance that the fish is ripe. This knowledge can be gained only by experience.

An attendant gets into the pen containing the females and catches a fish by the tail with his left hand, on which is worn a woolen glove or mitten as an aid in maintaining his hold. He kills the fish by a blow on the head with a club and, casting it on the trap floor, repeats the operation until from 40 to 50 have been killed. At some stations it is customary to cut off the tails at the base of the caudal

STRIPPING FEMALE CHINOOK SALMON, LITTLE WHITE SALMON (WASH.) STATION.

FERTILIZING EGGS OF CHINOOK SALMON, BIG WHITE SALMON (WASH.) STATION.

with a broadax, so that the fish may bleed freely. While this is not absolutely essential, it prevents the eggs from coming in contact with a large quantity of blood. The fish are washed by dashing water over them, the blood escaping through the open floor.

Male fish are then thrown out from their pen and left long enough to undergo the exhaustion necessary to permit their being handled without much difficulty.

The spawn taker uses a "straight-jacket," as it is called, merely for the convenience of holding the fish. This is a sort of trough made the average length of a salmon and hollowed out to fit its general shape. A female is picked up by the gills and placed in this device. With a sharp, short-bladed knife the spawn taker makes an incision from the vent through the thin abdominal wall along the side, and the eggs flow out into a spawning pan or bucket held by another attendant. This is immediately passed to a third man, while a fourth man picks up a male fish. Grasping the tail of the fish with his left hand, and thrusting its head under his right arm, or in the case of a larger fish, between the knees, with his right hand he presses the milt out upon the eggs as soon as possible after they are taken. The eggs and milt are then thoroughly mixed by stirring with the hand. After being allowed to stand for a few minutes the milt is washed off, and the eggs are transferred to buckets and carried to the hatchery. Here they remain undisturbed until they have become water hardened and separate, when they are measured into egg baskets. The male fish is returned to the stream for use in future spawning operations.

Blueback salmon in Alaska begin to leave the lakes in late August and September and ascend the streams to their headwaters to spawn. At suitable places near the mouths of such streams the fish are intercepted by racks, and seining operations are conducted in the waters below. The seine used, which is about 300 feet long, is loaded on a boat at a point below the rack, and, one end being held on shore, the remainder is distributed to posts projecting from the rack to the farther side of the stream. From here the boat continues downstream in a long sweep until the seine is played out to form a semicircle. The end last played out is operated by a man in waders, while the boat with the lead rope continues on to the starting point on the shore. At a given signal men stationed along the rack release the seine and follow it as it is hauled toward the shore, the two ends being brought together so as to completely envelop the fish, which are gradually worked toward the center. The seine is then stretched or hung on horses or tripods, and men equipped with woolen gloves grasp the corralled fish by the tail, segregate the sexes, and distribute them in boxes conveniently placed for the purpose. These boxes, supported on legs about 3 feet long, are made of three-fourths-inch lumber and divided by partitions into from 8 to 10 cells, each of them large enough to hold a fish placed in it head foremost, leaving about 6 inches of the tail protruding.

An operator stands at a box in which females have been placed and assorts them to determine as to their spawning condition, placing the ripe ones in another box and throwing the unripe ones back into the stream. A second man stands at the box containing the ripe fish and removes them one by one, killing them by a blow on the head with a club. They are then placed on a spawning table having a top 2 by

10 feet in dimensions, 6-inch sides, and legs about 3 feet long, with a slope toward the operator at the other end. Across the table, for convenience in taking the eggs, is placed a small platform or bridge 1 foot in width, with a slope of about 30° toward the upper end of the table, the face of which is studded with sharp-pointed nails one-half inch long to hold the fish in place.

The spawn taker removes a fish from the table and places it on the platform with the head toward him, his left hand resting near the middle of its back. With his right hand he rips open the abdomen from a point between the pectoral fins to the egg vent by means of a sharp-bladed knife, having a guard which permits the blade to project three-fourths of an inch. If the eggs are ripe they are easily removed by slightly inclining the fish toward the lower side of the board, where they gently fall into a pan placed to receive them. The dead fish is then thrown aside and the operation repeated. After two females have been spawned a man at the opposite side of the table removes the pan, replaces it with an empty one, which has first been moistened with water, and passes the pan of eggs to the operator handling the male fish, to be fertilized. After fertilization has been accomplished, the eggs are turned into a washing box and held in a quiet current in the stream to clean up. This box somewhat resembles a corn popper in its construction, being made of fine-meshed wire and provided with a long handle and a hinged cover, with a clasp to hold it in position. In its bottom is a small trapdoor, operated by a lever near the end of the handle. After remaining in the stream a few minutes the eggs are emptied through the trapdoor into a bucket submerged about a foot under the surface of the water. Here they are held for half an hour to harden and are then carried to the hatchery, measured, and distributed in standard salmon-hatching baskets, 50,000 being placed to a basket.

HATCHING APPARATUS AND METHODS.

The hatching apparatus usually employed is the so-called standard salmon trough, with wire-cloth baskets. The troughs, which are generally constructed of cedar and redwood from 1½ to 2 inches, dressed, are 16 feet long, outside measure, and 14 by 6½ inches, inside measure. They are arranged in pairs, two or three pairs being placed end to end on different levels, with a fall of about 6 inches between each pair.

Metal partitions divide each trough into compartments just enough longer than the baskets to permit of their being raised and lowered and subjected to slight tilting. The essential feature of this trough is the perfection of water circulation attained by means of cross partitions or riffle dams inserted at either end of each compartment. These partitions are made of No. 20 galvanized sheet iron and are held in place by saw scarfs in the sides and bottom of the trough.

The first riffle dam is placed 7½ inches from the head end of the trough, reaches entirely across, and extends from the bottom to within about 1½ inches of the top. Two inches below this point a similar dam extends across the trough, reaching from the top to within 1½ inches of the bottom. Twenty-six inches farther down similar dams are arranged, and so on throughout the entire length of

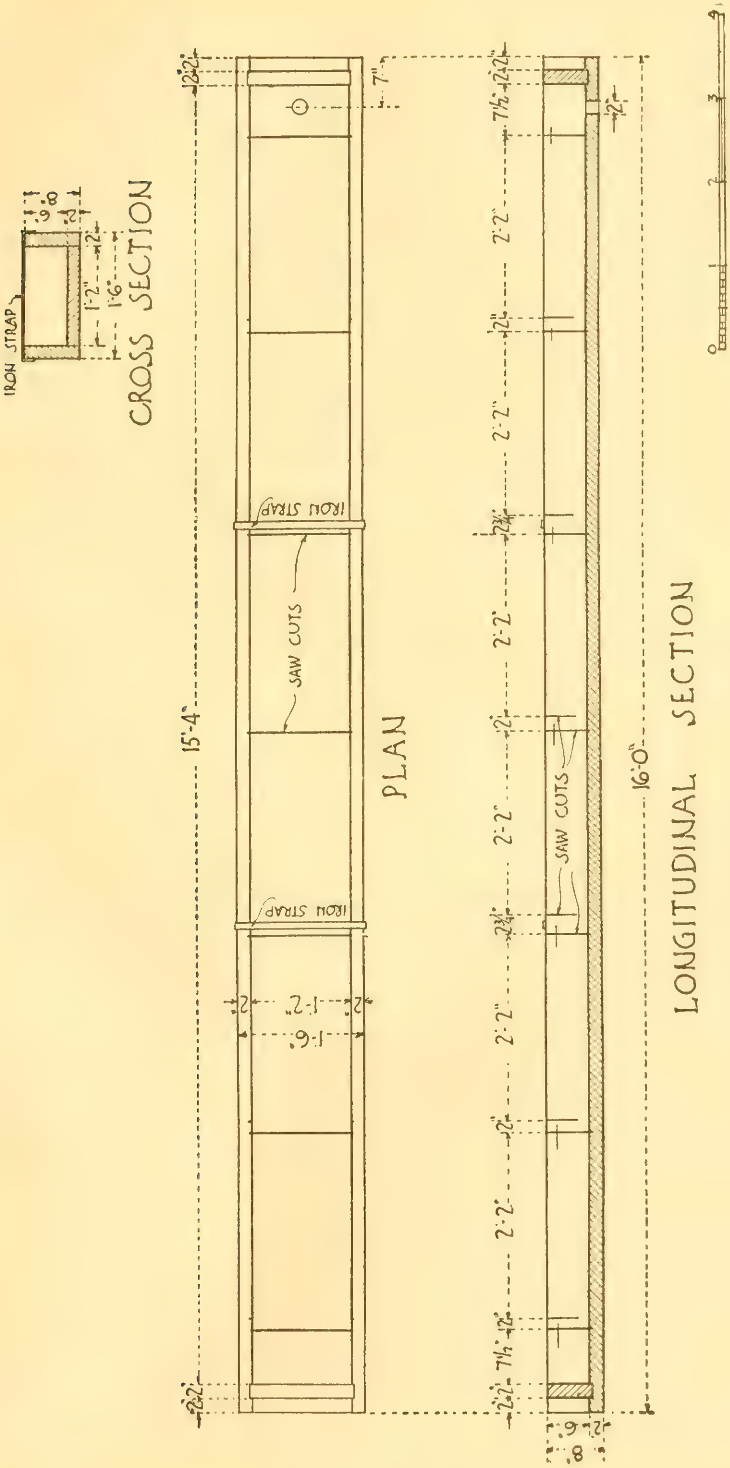


FIG. 6.—Plan of standard salmon-hatching trough.

the trough, with the exception of the space between the second and third and the fourth and fifth compartments. Here the dams are placed $2\frac{3}{4}$ inches apart for the accommodation of iron braces, which prevent the troughs from bulging. Only one dam is used at the foot of the trough. This reaches across and extends from the bottom to within $1\frac{1}{2}$ inches of the top. In the center of the space at the foot of the trough is a 2-inch outlet, provided with a hollow cedar or metal plug, placed at the proper height. The water is thus forced to flow under the upper dam upward through the basket of eggs, and thence over the lower dam, etc. The troughs are provided with canvas covers stretched upon light frames and made sunproof by saturation with asphaltum varnish, which is also thickly applied to the interior surface.

The egg receptacles are oblong-mesh wire-cloth baskets about $13\frac{1}{2}$ inches wide, 24 inches long, and from $5\frac{1}{2}$ to 6 inches deep, thus allowing them to project an inch or two above the surface of the water in the troughs. When wooden-rimmed baskets are used, the rim rests on the top of the trough and holds the basket 1 inch from the bottom. Arranged in this way the water passes under the riffle dam at the head of the compartment, beneath the basket, and then upward through the eggs. The metal rim, which has been adopted in recent years, is supported by metal lugs fastened to the edge of the basket, rests on the top of the trough, and holds the basket in the same position as the wooden rim. In both cases the basket, when in operation, should be kept flush against the lower riffle dam of the compartment in which it is placed, to force the ascent of the water through the eggs.

The number of eggs that can be incubated in a basket depends upon the species of salmon and the volume of the water supply. This varies with the chinook from 20,000 to 30,000; blueback, from 50,000 to 60,000; silver, from 30,000 to 35,000; humpback, from 40,000 to 50,000; and chum, from 33,000 to 38,000.

The eggs suffer no injury from being in numerous layers, as water is constantly forced through the mass, partially removing the pressure. The baskets are constructed of galvanized wire containing from four to six meshes per inch, three-fourths of an inch long, the size of the mesh varying with the size of the eggs to be handled. The oblong mesh permits the fry to pass through onto the bottom of the troughs when hatched, but it is not large enough for the passage of the eggs. The advantages of this apparatus are: (1) The top of the basket is above water, so that the eggs can not overrun or escape; (2) by tilting one end of the basket a little, or by lifting it and settling it back gently in place, the bad eggs are forced to the top and can be easily removed with the ordinary egg picker; (3) space is conserved, as the basket provides many times the number of eggs that could be accommodated on trays with an equal volume of water, the proper flow per trough being from 10 to 15 gallons per minute; (4) the ease and facility with which the mud can be discarded make it possible to remove all sediment collecting on the eggs by gently moving the basket up and down in the water several times.

The period of incubation of salmon eggs depends upon the water temperature. A very safe rule to follow is one originally formulated by Seth Green:

In a temperature of 50° F. the eggs will hatch in 50 days. Every additional degree of warmth lessens the incubation period by 5 days, and every degree lower than 50 prolongs it 5 days.

Salmon eggs are very hardy during the first few days, and while in this condition they are thoroughly gone over for the removal of the dead ones. At some stations it is customary after doing this to cover the eggs and leave them undisturbed until the spinal column is well formed, when the delicate stage has passed. This is not absolutely necessary, however, where skilled operators are employed. Men experienced in the work can handle the eggs throughout the entire period of incubation, and this is the most efficient method to pursue. When the number of unimpregnated eggs is great enough to warrant, they may be most advantageously removed by means of a salt solution, which should be applied only after the spinal column is well formed.

By means of this solution, which should consist of one part salt to nine parts of water, one is able to distinguish dead or unfertilized eggs at an early stage of development. The solution is held in a water-tight box or trough of 1-inch lumber, 40 inches long, 18 inches wide, and 12 inches deep. Inside of it is a second box of one-half inch lumber 3 inches less in width, 3 inches deeper, and provided with handles and a screen bottom. The dead eggs are removed with a net or scoop made of basket wire. The trough or outer box is filled to within a few inches of the top with water, and salt is added gradually and dissolved until the proper density is attained, this being determined by testing a few good and bad eggs in a small portion of the solution each time salt is added. This has been demonstrated to be a more satisfactory method than weighing or measuring, as salt readily absorbs moisture and varies in purity.

The box with the screen bottom is placed in the solution, wedged down, and a full basket of from 35,000 to 60,000 eggs poured into it. In less than one minute the good eggs will settle to the bottom, and the bad ones can be removed with the wire scoop. The inner box can then be lifted out and the good eggs returned to the basket and to fresh water, the whole process not requiring over three minutes. One solution can be used over and over again by adding sufficient salt to maintain a uniform density.

The box or trough was adopted because of convenience in handling and because it furnished the necessary amount of surface, a very important feature to consider, as the bad eggs, if crowded, would cause the good ones to float by mingling with them. Quite an extensive use of this method of cleaning the eggs has shown no deleterious results, and where there are over a thousand dead eggs in the basket at the time the empties are turned, the use of the solution will effect a saving of labor.

PACKING SALMON EGGS FOR SHIPMENT.

Cases made of 1-inch lumber and of suitable size for packing on horses or mules are used for moving eyed salmon eggs over rough mountain trails from the collecting fields. The bottom of the case is lined with a thick layer of moss and covered with a piece of mosquito netting. On this a layer of eggs is spread and covered with netting. Successive layers of moss, netting, and eggs are thus arranged up to the middle line of the case, where a firm wooden parti-

tion is fastened on. The packing is then resumed as before until the case is filled, when the cover is screwed on, and the eggs are ready to be transported.

For shipping eyed salmon eggs to various points in the United States what is known as the Atkins-Dinsmore case has been quite generally substituted for the old tray-shipment method described on page 84 of the Appendix to the Annual Report of the U. S. Commissioner of Fisheries for 1897. Eggs can be transported in the Atkins-Dinsmore case as soon as the eye spot is plainly visible and up to within a few weeks of hatching. When shipped at too late a period of development, however, the eggs will hatch en route and the embryos perish.

This method of packing eggs * * * has the special advantage of making a comparatively light package—a factor of great economic importance in transportation. The outside case may be an ordinary box of suitable dimensions.

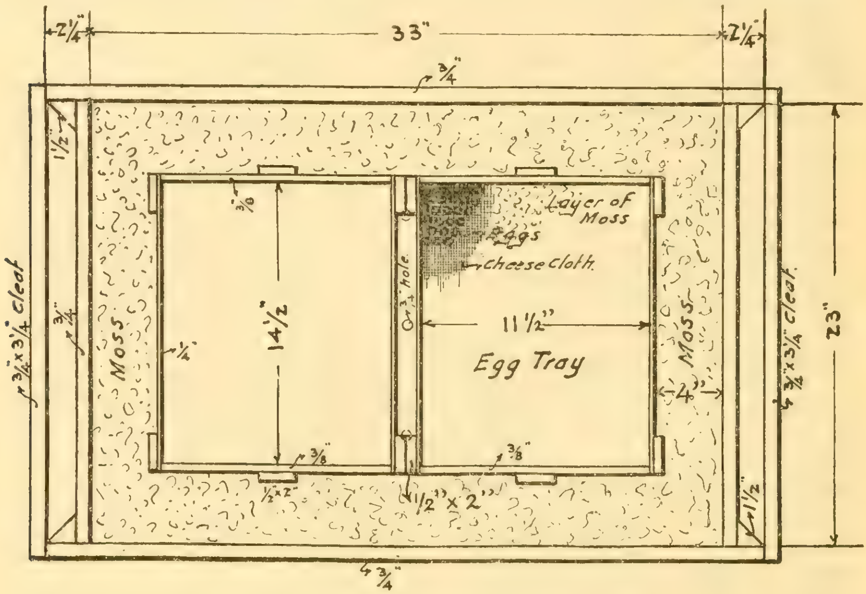


FIG. 7.—Atkins-Dinsmore shipping case. Plan.

In it are packed, surrounded by moss, several boxes made of three-eighths-inch boards, and usually 12 inches wide by 15 inches long by 3½ inches deep, each box containing a mass of 10,000 to 20,000 eggs in mosquito netting, with moss around all sides. No ice is used, care being taken that the packing be done in a temperature below 50°, that all packing material be kept in a place slightly below freezing point, and that the moss in which the eggs are packed be sprinkled with snow. This method of packing is an economical one for shipments of eggs of Salmonidæ during cold weather, but can not advantageously be used for eggs of spring-spawning fishes unless there is available a cold-storage room in which to do the packing. Recently the superintendent of the Baker Lake (Wash.) station, who has had occasion to ship eggs of steelhead trout and Pacific salmon in warm weather, has packed them in light cases with alternate layers of moss, and then placed two tiers of these thin cases side by side in an outer case with a large hopper of ice over the whole, the drip passing down between the two tiers of inner cases. The chief advantage of this case for long-distance shipments is in the fact that less ice is required than in other forms of cases using ice, with a consequent saving in transportation charges. It can also be used in warm as well as cold weather.[a]

[a] Titcomb, John W. Loc. cit., pp. 743.

While the methods described above have been successfully employed in the transportation of eggs across the United States and

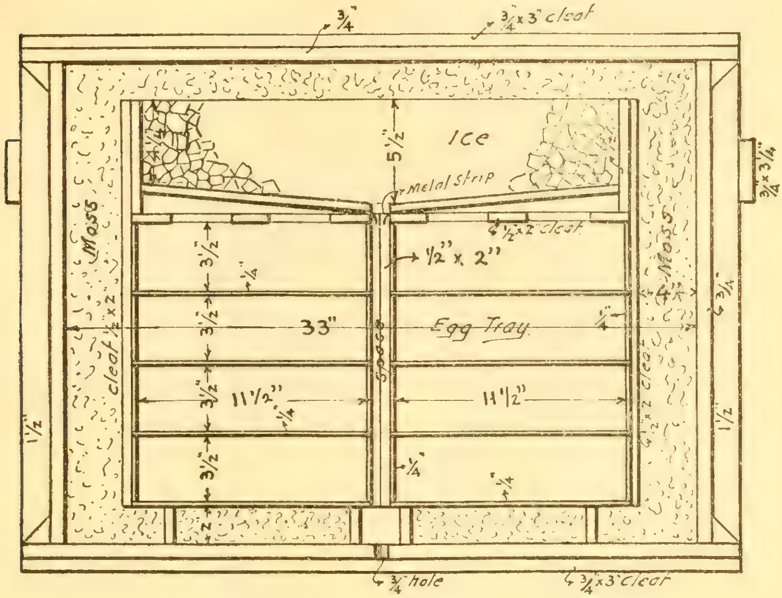


FIG. 8.—Atkins-Dinsmore shipping case. Longitudinal section.

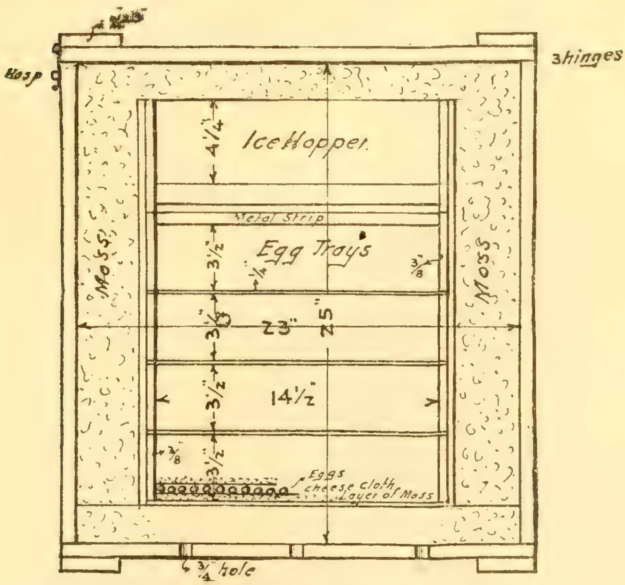


FIG. 9.—Atkins-Dinsmore shipping case. Cross section.

also to Europe without an attendant, shipments of eggs to points south of the Equator, usually leaving this country in winter and arriving at their destination in summer, have called for more than

usual attention to the methods of packing them, and a caretaker is quite essential.

The Argentine shipping case, successfully used under such conditions, has been described by John W. Titcomb as follows:[a]

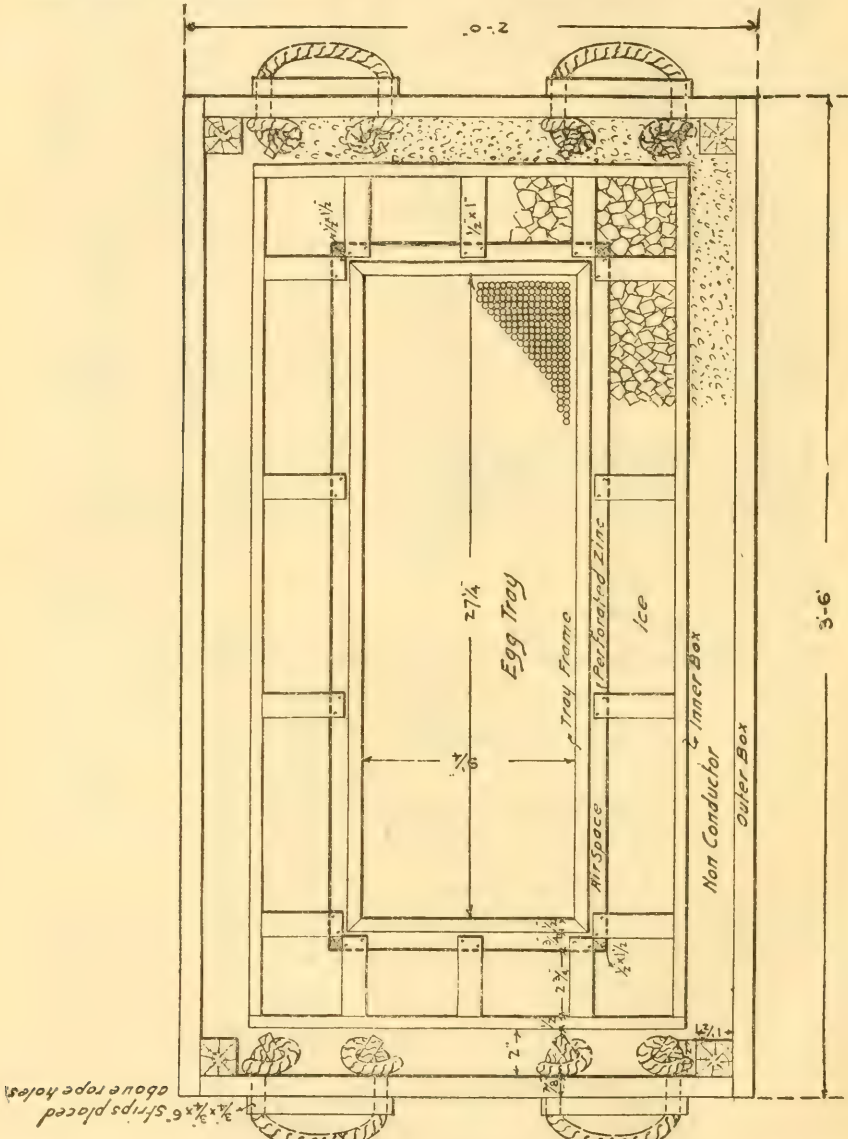


Fig. 10.—Argentine shipping case. Plan.

A highly efficient form of shipping case has been developed during the past few years for the transportation of eggs of the Salmonidæ from this country to Argentina. This case is 3 feet 6 inches long, 2 feet wide, and not exceeding 30 inches high, outside measurement, and is constructed of selected tongued and grooved lumber. It has double walls, with bottom and top common to

[a] Titcomb, John W. Loc. cit., pp. 747–749.

both, the 2-inch space between the walls being filled with nonconducting material, preferably tightly packed shavings. Between the inner wall and the stack of trays is a 2¾-inch space for ice, separated from the trays by perforated zinc. Between the latter and the trays, in a three-fourths-inch space, are the vertical supports of the zinc, viz, double corner supports, one being one-half by 1½ inches, the other being one-half by 1 inch; two intermediate supports of one-half by 1 inch material, which are provided on either side of the case and one at each end; and cross braces of one-half by 1 inch material, which extend from the uprights to the inner walls of the case.

The ice hopper, 3 inches in depth, and having the same outside dimensions as the trays, rests upon the latter and fills the space between the uppermost tray and the top of the case. It has a perforated zinc bottom, and, to facilitate handling, cleats of small ropes are attached to it. The top of the case is insulated with a 2-inch thickness of nonconductor covered with sheet zinc, this insulation fitting closely into the chest when closed, and thus covering not only the ice hopper, but the ice spaces around the sides as well. In the bottom grooves lead to a three-fourths-inch drain hole, which is provided with a

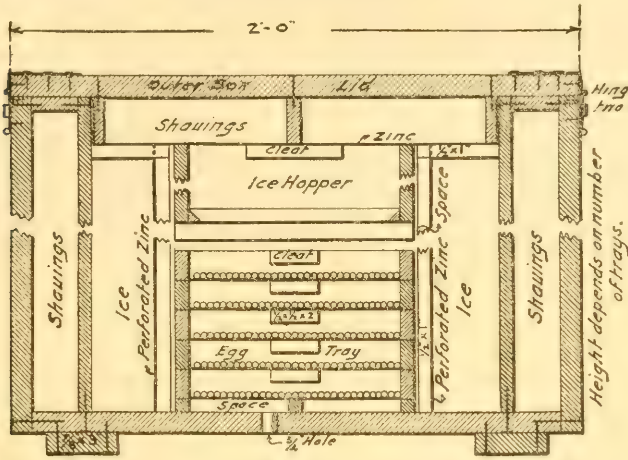


FIG. 11.—Argentine shipping case. Section.

cork. Two cleats seven-eighths by 3 inches are attached lengthwise to the bottom on the outside.

The trays are one-half inch deep, 27 inches long, and 9 inches wide, inside measurement, the frames being of one-half by one-fourth inch material. The bottom of each tray is covered with wire cloth, No. 25 gauge, about 12 meshes to the inch, stretched tightly to prevent sagging and consequent uneven distribution of the drip water. A narrow binding of cloth is tacked around the bottom of each tray to prevent the wire edge from catching on the mosquito-net covering of the tray beneath. On the inside ends of the trays are fastened short lifting cleats, and wedges hold the trays securely in place. The bottom tray rests on three one-half-inch cleats extending lengthwise of the case, one at either side and the other in the middle. It is important to have the trays of uniform size that they may be interchangeable.

The trays and interior of the case are coated with asphaltum. To facilitate opening from either side, four hasps are used, two on each side of the case. Two rope handles side by side are placed on each end of the case, with a cleat of three-fourths-inch material just above the holes for each handle.

Eggs selected for shipping should barely show the eyespots without the aid of a glass. In packing, a layer of damp moss is spread one-fourth of an inch deep as evenly as possible over the tray bottom, and upon this is placed a covering of mosquito net or bobbinet. The eggs are laid upon the netting one or two layers deep, spread to within one-half inch of the tray frame, and covered with another piece of netting to keep them separate from the moss, which is sprinkled in a light layer over it, filling the tray. The netting is cut large enough to extend over the outer edges of the tray, so that the eggs may not be disturbed when a tray is lifted for examination.

On shipboard, as the greater part of the journey is made, the cases of eggs are kept in one of the fruit or cold-storage rooms having a temperature of about 38° F. To this room the attendant has access, and it is his duty daily to moisten the eggs by pouring through the ice hopper water of the same temperature as the eggs, 34° to 35°. The ice compartments are frequently replenished, and the eggs are picked over whenever necessary.

It will be seen that the method of caring for the eggs is not novel. The chief improvements in the case are to make it easy for the caretaker to handle the eggs in the crowded quarters of a ship's storage compartments and to facilitate handling each individual tray.

WATER SUPPLY FOR HATCHERY.

One of the most important factors to be considered in connection with salmon propagation is the water supply, which should always be taken from a stream that salmon are known to frequent for spawning. Spring water or water from a spring-fed creek is objectionable, as it shortens the incubation period, bringing out the fry at an earlier period than if hatched under natural conditions and at a season of the year when the natural food supply in the streams is at its lowest ebb.

In choosing a site for a salmon hatchery the matter of conveying water thereto at a proper height for a gravity service should be planned for, if possible. The supply may be conducted through a substantially built flume or by a pipe line, the dimensions of either to be governed by the extent of the work contemplated, having in mind the further development of the plant and the size of the pond system it is desired to establish. The point for the intake should be selected with the view to its protection, so far as is possible, from the ravages of floods and ice. This may be accomplished by means of piling or sheer booms. In some cases the construction of a low dam will be required in order to raise the water to the proper level to enter the flume or pipe line.

Water taken from an open stream always contains more or less sediment, necessitating the use of a filter for the elimination of the greater part of it. A small quantity of sediment in the water supply is not objectionable; in fact, it is apparently beneficial.

Where a proper fall can be secured, with a sufficiently rapid current at the point of intake, the water can be delivered by means of a current wheel, provided climatic conditions are favorable to its operation. A wheel for this purpose should be constructed on the order of a large undershot water wheel, with buckets on the outside of the rim. As the wheel revolves the buckets fill and empty into a trough or tank connecting with the supply flume leading to the hatchery.

CARE OF THE FRY.

The eggs of the chinook salmon, as do those of the other Salmonidæ, hatch very gradually at first, only a small percentage coming out the first day. But the number increases daily until the climax is reached, when large numbers of young burst their shells in a single day. Great care and vigilance are required at this time. The vast numbers of shells rapidly clog up the guard screens at the outlets of the troughs, which should be kept as free as possible by thorough cleansing from time to time.

FIG. 1.—HATCHERY AND FEEDING PONDS, DUCKABUSH (WASH.) STATION.

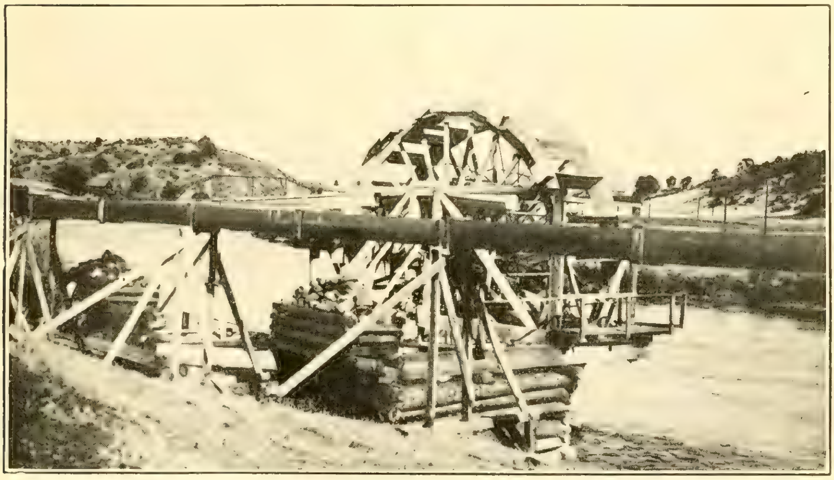


FIG. 2.—CURRENT WHEEL, HORNBROOK STATION, KLAMATH RIVER. CALIF.

After all the eggs are hatched and the baskets and riffle dams are removed from the troughs, each trough is divided into three equal compartments for holding a certain proportion of fry by inserting in the saw scarfs which carry the riffle dams 7 by 14⅝ inch screens, made of No. 9 gauge zinc. The size of the perforations, which are horizontal in shape, should be governed by the species handled, and the four outer edges of each screen should have a one-half inch margin of unperforated metal. The number of fry that can be held until the absorption of the yolk sacs ranges from 30,000 to 50,000 per trough, varying with the species and the water supply available.

In the deep trays the newly-hatched fish are mixed with unhatched eggs, and the advantage of the oblong mesh in the bottom of the trays becomes apparent. This mesh is too narrow to allow the eggs to fall through, but the hatched fish, being comparatively long and narrow, easily slip through the long meshes into the space below. They should be assisted by gently raising and lowering the tray at intervals, taking care not to raise them out of the water, as at this tender age a slight pressure against the wire of the tray will often produce fatal injuries. On this account too much caution can not be exercised in regard to handling them out of water during the first stages of the yolk-sac period, for the injuries can not be seen at first, and often the death of the fry is the first warning that they have been injured.

After the eggs are all hatched and the young fish are safely out of the trays and on the bottom of the troughs, their dangers are few, and they require comparatively little care. Almost the only thing to be guarded against at this period is suffocation. Even where there is an abundance of water and room, with a good circulation, they often crowd together in heaps, or dig down under one another until some of them die from want of running water, which is not an inch away from them. The best remedy in such a case is to thin them out.

FEEDING THE FRY.

In recent years it has become well recognized that real success in the propagation of the Pacific salmons is determined in large measure by the extent to which the young are reared to the fingerling stage before liberating. The former practice of planting defenseless fry in wholesale numbers a short time before the final absorption of the yolk sac is now almost obsolete. This pertains particularly to the blueback and silver salmons and in less degree to the chinook, for these are known to pass a part or the whole of their first year's existence in fresh water, a period of residence that has been determined conclusively, chiefly as the result of general investigations and study of salmon scales conducted in recent years by Dr. C. H. Gilbert, of Stanford University, Calif.

The demand for fingerlings which has naturally followed this recognition of the great value of fingerlings over fry has developed the necessity for a cheap food, one that will furnish proper nourishment for the young fish and be available in large quantities, as the cost of liver, which has long been a favorite article of food for young fish on the west coast, has become prohibitive, except for occasional use and to afford a change of diet for a short period.

One of the first cheap foods to be utilized in large quantities by the Bureau of Fisheries was the Columbia River smelt, which was first tried at the Oregon stations about five years ago. These fish can be purchased during the run at the height of the season for $20 per ton at a cold-storage plant in Portland, Oreg. An additional charge of $20 per ton covers sharp freezing and storing for a period of six months, and this, together with transportation charges, makes the average cost of the fish about 2½ cents a pound delivered.

Smelt have been fed both raw and cooked. When used in the raw state the fins and heads are removed, and the fish are ground once through the coarse plate of an Enterprise meat chopper, after which they are run through the fine plate twice. However, this method has not proved very satisfactory, as smelt are very oily, and, in feeding, difficulty has been experienced in keeping the troughs clean. Intestinal trouble is also feared from the innumerable small, sharp bones.

The method which has given most satisfactory results is to place the smelt in 50 or 100 pound lots in a farm kettle and cook them until the bones become softened. After this a quantity of the cooked mass convenient for handling is placed in gunny sacks and permitted to drain thoroughly. The mass in the sack is then transferred to a press of convenient size, operated by an ordinary house jack, and is pressed into cakes 12 inches square and varying from 3½ to 4 inches in thickness. The burlap forming the sack is peeled away and is serviceable for further use. Quantities of this food can be prepared at one time, and, if kept in a cool, dry place, will remain in a wholesome condition for several days. When needed for food it is grated by means of a homemade power grater and screen, the degree of fineness depending upon the age of the fish to be fed. After this operation it presents the appearance of coarse meal. It can be scattered over the surface of the water and is cleaned up by the fish before it reaches the bottom. Prepared in this manner it makes a good, clean, rich food, and the fish take it readily. Its cost is also very moderate.

Beef and hog melts have been successfully used in conjunction with mush, both for the purpose of varying the diet, and with the view of eliminating the use of liver in large amounts after the fish are a few weeks old. The cost of this material will average about 3 cents per pound.

Culled canned salmon, or "do overs," have also been employed to good advantage in the feeding of young salmon. The contents of the cans are first thoroughly heated and then pressed and grated in the manner described above in the preparation of smelt. Particular attention is invited to this method of using canned salmon as fish food in view of the fact that considerable complaint has been made as to the results of its use in the past. If prepared in the manner specified, the material is certain to give satisfactory results.

After several years' success in the feeding of canned salmon it occurred to representatives of the Bureau that the fish used in a spawning operation, if properly preserved and prepared, would make a good and inexpensive food. Instructions were accordingly issued to all the west coast superintendents, including those in Alaska, to put up a quantity of the spawned salmon, and it is extensively used at those stations at the present time. After being relieved of their eggs the fish are skinned, split, and carefully boned.

They are then placed in tanks or barrels, with alternate layers of salt, water being added in sufficient amount to keep the brine well over the top layer.

The material has also been prepared by dry salting in dairy salt and packing it in a dry, tight box or other container, weighing it down in a solid mass. The fish are then taken out, rinsed in fresh water, and hung over a pole in the dry house. A slow heat is applied at first to toughen the fiber, following which they are kept in the dry house until quite hard and dry, when they are packed in boxes between layers of papers to absorb any moisture and held in a dry storage until needed.

Still another method was tried at the Bureau's California stations, where a quantity of sundried or sun-cured salmon was prepared without salt, the climatic conditions being favorable for curing salmon in that manner until late in the fall.

Several methods of preparing this food were adopted. In all cases, however, the fish were first soaked well, preferably overnight, in running water, to remove the salt. Some were then cooked, pressed, and grated; others were prepared by grinding in an Enterprise meat chopper and mixing the meat with a mush made from middlings. Quantities have also been prepared and fed in the raw state. In all forms the material has proved excellent, and when used in conjunction with small quantities of liver or plucks, to vary the diet, the results have been eminently satisfactory. Its cost, based on the lots which have so far been put up, has averaged 1 cent a pound. When prepared in large quantities, it should be materially cheaper.

Most excellent results were attained with this food at one of the Puget Sound stations of the Bureau of Fisheries. In a slough where several hundred thousand fish had been placed at the time of the absorption of the yolk sac, sides of salted salmon were laid on the bottom. As the meat softened, hundreds of young fish could be seen working on it, and it was finally all devoured. The fish remained in the slough under the care and observation of an attendant, attained a rapid growth, and developed into splendid fingerlings.

Under such an arrangement the expense of salmon rearing is reduced to a minimum, and work of similar character should be encouraged on all salmon streams where the natural conditions are favorable.

In connection with rearing operations the importance of providing a mixed diet can not be too strongly emphasized. If the principal food consists of the prepared fish, a food of liver and mush should be given frequently. Where this is done as often as once a day, it will be found to produce the most rapid growth. No matter how good any one food may be, nor how cheaply it is prepared, the best possible results will be attained where a variety is used.

PLANTING YOUNG SALMON.

When the salmon have reached the proper age for distribution, they should be released on or near the natural spawning grounds, in the most protected spot that can be found. It is unwise to liberate young salmon before they have absorbed the yolk sac, and where the

necessary facilities exist it is advisable to feed them until they have attained a length of at least 2½ inches, as fish of that size are much more likely than fry to elude their enemies.

The following information bearing upon the ages at which salmon should be planted is taken from reports of Dr. C. H. Gilbert, Professor of Zoology, Stanford University, on investigations made by him for the U. S. Bureau of Fisheries and for the commissioner of fisheries of British Columbia:

The blueback spawns normally either in its fourth or fifth year, the chinook salmon in its fourth, fifth, sixth, or seventh year, the females of both species being preponderatingly four-year fish.[a]

The young of both blueback and chinook salmon may migrate seaward shortly after hatching, or may reside in fresh water until their second spring. Those of the first type grow more rapidly than the second, but are subject to greater dangers and develop proportionately fewer adults.[a]

[In the case of the blueback salmon] examination of scales from all the important blueback streams of the Province has shown for each basin that adult fish are derived from yearling migrants, to the practical exclusion of those which migrate as fry. Out of some 8,000 bluebacks of the 1913 run, only 12 fish seemed with some probability to have developed from fry migrants. It would seem, then, that with few exceptions the fry of this species perish after entering the sea. The only alternative to this conclusion is that fry develop in the sea in precisely the same manner, at the same rate, and with all the local peculiarities marking those of their own basin, which develop for a year in their native lake. To one acquainted with all the facts, such an hypothesis appears impossible and absurd.[b]

The deplorable waste occasioned by the loss of vast numbers of fry can not be checked, it would seem, in the case of such progeny as are the result of natural spawning. They can not be held back from migrating as fry if the instinct seizes them. But the case is different in hatchery practice. Here [British Columbia] it is still the custom to release the young as soon as the egg sac is absorbed and free feeding begins. But, in view of the conditions here pointed out, it would appear to be imperative that the fry of the year hereafter should be held in troughs or ponds and fed until midsummer, when the time for downward migration will have passed. They can then be deposited in the lake, with full confidence that they will pass to sea as yearlings the following spring.[b]

Silver salmon spawn normally only in their third year. The young migrate either as fry or yearlings, but adults are developed almost exclusively from those which migrate as yearlings.[a]

Chum salmon mature normally either in their third, fourth, or fifth year; humpback salmon always in their second year. The young of both species pass to sea as soon as they are free swimming.[a]

The term "grilse" as used for Pacific salmon signifies conspicuously undersized fish which sparingly accompany the spawning run. They are precociously developed in advance of the normal spawning period of the species. So far as known, the grilse of the chinook, silver, and chum salmons are exclusively males, of the blueback, almost exclusively males, except on the Columbia River, where both sexes are about equally represented. The larger grilse meet or overlap in size the smaller of those individuals which mature one year later at the normal period.[a]

The great differences in size among individuals of a species observed in the spawning run are closely correlated with age, the younger fish averaging constantly smaller than those 1 year older, though the curves of the two may overlap.[a]

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[a] Gilbert, C. H.: Age at maturity of the Pacific coast salmon of the genus Oncorhynchus. Bulletin, U. S. Bureau of Fisheries, Vol. XXXII, for 1912, pp. 21–22. Washington, 1913.

[b] Gilbert, C. H.: Summary of Contributions to the life-history of the sockeye salmon. (No. 1.) British Columbia. Report, Commissioner of Fisheries, for 1913, pp. R10–R11. Victoria, 1914.

ARTIFICIAL PROPAGATION OF STURGEON

REVIEW OF STURGEON CULTURE IN THE UNITED STATES

By Glen C. Leach
Assistant in Charge Division of Fish Culture
U. S. Bureau of Fisheries

and

ARTIFICIAL PROPAGATION OF STURGEON IN RUSSIA

By Nicolas A. Borodin
Formerly Chief Specialist in Fish Culture
Russian Department of Agriculture

Appendix III to the Report of the U. S. Commissioner of Fisheries for 1919

ARTIFICIAL PROPAGATION OF STURGEON.

Part 1. REVIEW OF STURGEON CULTURE IN THE UNITED STATES.

By Glen C. Leach,
Assistant in Charge Division of Fish Culture, U. S. Bureau of Fisheries.

A number of attempts have been made in the United States at various times to propagate the sturgeon by the artificial manipulation of the eggs, but in every instance they have been rendered practically null by certain unusually persistent difficulties. An account of the efforts may be of interest and value, particularly in view of the fact, as appears from the accompanying paper of Prof. N. A. Borodin, formerly connected with the Russian department of agriculture, that most of these obstacles were overcome in the course of some experimental work performed under his direction as chief specialist in fish culture in that department.

The first attempt at sturgeon propagation by a representative of the United States Government was in 1888 at Delaware City, Del., in the course of an investigation of the sturgeon fishery by Dr. John A. Ryder (Bulletin, U. S. Fish Commission, 1888), but experiments along that line had been conducted by Seth Green at New Hamburg, N. Y., as early as 1875, and were described by him in his book entitled "Fish Hatching and Fish Catching," published at Rochester in 1879.

The eggs for the experiment at Delaware City were obtained from fish landed for the market. A number of such fish were examined, but of the various lots of eggs secured only one small lot was successfully hatched. In this instance they were taken by opening the female fish, and after fertilization had been accomplished by the application of milt secured in the customary manner, the eggs were spread in a single layer over the cheesecloth bottoms of shallow boxes and anchored in a small sluiceway where there was a constant current of water.

The same drawbacks—viz. difficulty in finding ripe eggs and milt at the same time, imperfect aeration of the eggs during the incubation period, and the unusual tendency of the eggs to develop fungus—were again encountered in the course of a second attempt to propagate sturgeon at Delaware City by Dr. Bashford Dean in 1893. The work of that year disclosed the feasibility of using as a fertilizing medium milt secured by the removal of testes from male fish which

were not sufficiently matured to void the secretion by the application of external pressure. The milt was separated from the cut testes by straining through a coarse cloth and proved just as effective as that taken from live fish, even after being held for several minutes in the rubber-bulb container. In an effort to overcome past troubles, the style of hatching apparatus was changed. The eggs were spread evenly under water on shallow trays in boxes whose sides and bottoms were covered with metal gauze. The necessity for quick handling soon became apparent, as the viscid nature of the eggs causes them to cling so firmly to any surface with which they come in contact that they are invariably injured in the attempt to loosen them, and it was found that if not placed on the trays within 10 or 15 minutes after being fertilized they would form into a gluelike mass, which speedily became compact and hard. After allowing sufficient time for the eggs to become firmly attached, the trays containing them were fitted into the boxes and anchored in various places in the river bed.

By the end of the second day thereafter the eggs in the boxes, which had been moored in marginal waters having a sluggish current and carrying much silt, were found to be entirely enveloped in fungus and dead. Those placed where the water current was strong and comparatively free from sediment had sustained a loss of 60 per cent by the close of the fifth day from the same cause, while those which had been installed in a strong current in salt water showed practically no fungoid growth and were hatched in good condition.

In the spring of 1890 Frank N. Clark, superintendent of the Northville (Mich.) station, made preparations for the collection of sturgeon eggs at Fox Island, Mich., and under his direction 142 female and 32 male fish were examined between May 26 and June 14. Examination showed that 23 of the females had already spawned, 98 were very immature, the eggs in 6 were nearly ripe, and 5 were in spawning condition. Of the males 21 were hard, 2 almost mature, and 9 entirely so. In all, 20,000 eggs were secured and fertilized by cutting open and squeezing the milt sacs after moistening them with water. Much difficulty was experienced from adhesion, three hours of constant stirring being required to break up and separate the bunches of eggs. Ninety-five per cent of them were developed to the eyed stage, but shortly afterwards a growth of fungus began spreading in the floating boxes in which they were being incubated, and, as a result, very few of the eggs were hatched. Had it been possible to incubate them in whitefish jars it is estimated that at least 85 per cent would have been saved.

In the course of experimental work conducted in 1901 on the Missisquoi and Lamoille Rivers, tributary to Lake Champlain, efforts were made to hold green sturgeon in artificial inclosures for ripening. These efforts proved utterly futile, as in every instance the eggs caked together in a hard mass and development was arrested. Notwithstanding the great difficulty experienced in securing ripe eggs and milt together, 1,500,000 eggs were taken and fertilized, and their viscosity was effectively overcome by the method that is employed for the separation of pike-perch eggs. They were then successfully hatched in McDonald jars, the incubation period being

about six days in a water temperature of 65° F. The fish from which they were secured were taken especially for the work, and their violent struggles when caught frequently resulted in the loss of many of their eggs. Such losses were unavoidable, as it was possible to distinguish a ripe female only when the eggs ran from it after it was taken from the water.

In 1911 experimental sturgeon propagation was undertaken in Minnesota in the Lake of the Woods region. In advance of the season's run of fish an inclosure large enough to hold 30 adult sturgeon was constructed in Rainy River, and a hatching apparatus of sufficient capacity to accommodate 3,000,000 eggs and fry was set up in a convenient building. During the spring 16 sturgeon were captured in a pound net and transferred to the pen. Though held for several months under apparently favorable conditions, they failed to mature, and in the following October they were released without having produced any eggs. Another trial was made in the following year with the same results.

From the observations made it was concluded that sturgeon do not spawn until the water has attained a temperature of 60° F.; that the eggs do not ripen in fish held in confinement; and that unless nearly ripe males are available when the eggs are taken no results can be expected. The spawning season at the various grounds has always been short, seldom exceeding three or four days. It is believed that jars similar to those used in the propagation of whitefish and pike perch are the most suitable form of equipment for the development of sturgeon eggs.

Part 2. ARTIFICIAL PROPAGATION OF STURGEON IN RUSSIA.

By NICOLAS A. BORODIN,
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Every fish-culturist knows how difficult it has been to secure any genuine success in the artificial propagation of any species of sturgeon of the genus Acipenser. There must be acknowledged almost complete failure in both America and Europe as far as practical results go. One drawback has been the difficulty of keeping sturgeon eggs alive and sound, owing to their liability to be attacked and killed by Saprolegnia and other kinds of fungus. Yet another and very serious matter has been the scarcity of sturgeon in the rivers and lakes; in fact, these fish in many waters have become practically exterminated, and there has been no possibility of securing ripe eggs.

While America and western Europe have lost most of their sturgeon supplies, Russia still remains rich in sturgeons, especially the rivers emptying into the Caspian Sea—the Volga, the Kura, and the Ural. Even in these waters, however, there has occurred positive diminution in the number of sturgeon, and it is the general belief that, in order to prevent the entire extermination of these fish, it is quite necessary to resort to artificial propagation on a large scale.

Just prior to the outbreak of the war the central administration of the fisheries in Russia received a special appropriation for sturgeon propagation. Three of the commercial species were selected for attention, namely, *Acipenser ruthenus*, a small fish living in the Volga; and *A. guldenstadti*, a Russian sturgeon, and *A. stellatus*, or starry sturgeon, both living in the Caspian Sea and ascending the Volga, Kura, and Ural Rivers in spring. Temporary stations for the propagation of *A. ruthenus* were established and operated in the Volga in 1913, 1914, and 1915; one station for the propagation of *A. guldenstadti* was erected on the Ural in 1915, and another on the Kura in 1914, for handling both the starry and the Russian sturgeons.

There are not at hand the exact data on the work accomplished as regards the number of eggs hatched and fry planted, but the figures for *A. ruthenus* run into tens of thousands and for *A. stellatus* and *A. guldenstadti* into several hundreds of thousands. Most of the fry were planted several days after hatching, but a considerable number of fry of the Russian sturgeon were reared for several months, and some specimens were carried in an aquarium for five or six months, until they became too large for their quarters.

There have been some interesting developments in sturgeon propagation in Russia in the past few years, and I will try to describe the methods employed.

Two of the most important deductions from the investigations made during the experimental work are that sturgeon eggs become ripe and suitable for impregnation only when the male and female fish are kept together in the same pond or reservoir and that the spawning act takes place probably only at night. These two observations explain why it has always been very difficult to get ripe eggs from sturgeons caught during daytime or kept in ponds or inclosures with the male and female fish in separate compartments.

In our experiments, specimens of *A. ruthenus* have been held in large ponds, and their eggs have become ripe. Russian sturgeon have been retained in a reservoir about 32 feet long, 11 feet wide, and 6 feet deep, supplied with a current of water pumped directly from the Ural River. One night these fish spawned, and two days later there were found in the mud at the bottom of the pond thousands of eggs. Some of these fish hatched into healthy fry, but, as is always the case under natural conditions, most of them had not been fertilized, and therefore they perished.

With regard to artificial propagation of sturgeon, as elaborated by Russian fish-culturists in the latest work, the methods have been as follows: As the eggs flow from the female sturgeon they have a tendency to become united into a glutinous mass, which must at once be prevented. We received good results by stripping the eggs into a wire screen, washing them thoroughly with river water, and then putting them in a tin pan and fertilizing them with milt diluted with water. Several minutes later, before the eggs had become sticky, we again washed them thoroughly with river water, which at this time in the Ural and Kura Rivers is very turbid and of a yellow color, because of the enormous quantity of clay and sand in suspension. By such use of muddy river water analogous to the employment of swamp muck or of starch for overcoming the adhesiveness of pike-perch eggs in the United States, we counteracted the stickiness of the sturgeon eggs, which thereafter lose that quality and become easy to handle in any fish-hatching apparatus. We obtained quite good results in using two very different kinds of apparatus, namely, the Williamson trough and the Chase jar; but in both cases we preferred to employ not running water, which is always a little muddy, but filtered water without circulation and with constant aeration.

After three or four days of development the eggs hatched, and thousands of fry were obtained. For the first four or five days the young do not require any external food, having a sufficient quantity of nourishment in their yolk sac; but after that period we introduced into the troughs and jars living food consisting of the smallest fresh-water crustaceans (Daphnia, Bosmina, etc.) collected in small, warm waters with fine-meshed nets. The fry soon begin to search for these crustaceans. When they become larger and accustomed to take food, we begin to feed with chopped earthworms, of which young sturgeon are very fond. Fed in this way sturgeon grow very rapidly, attaining during the first month a length of about 1½ inches and during five months 10 to 11 inches. Fry of two to three months have already begun to closely resemble the adults and are very pretty fish.

SOME PLANTS OF IMPORTANCE IN PONDFISH CULTURE

By Emmeline Moore, Ph. D.

Appendix IV to the Report of the U. S. Commissioner of Fisheries for 1919

CONTENTS.

SOME PLANTS OF IMPORTANCE IN PONDFISH CULTURE.

By Emmeline Moore, *Ph. D.*

Contribution from the U. S. Fisheries Biological Station, Fairport, Iowa.

INTRODUCTION.

It is a matter of importance in the production of pondfish to control the growth of aquatic vegetation. This can not profitably be done until it is known what plants enter directly into the fish dietary or contribute indirectly to the support of the various animal forms upon which fish feed.

There is little precise knowledge of the natural food of the advanced fry and young fingerlings of our ponds and streams. Nearly all of the examinations of the food content of fishes refer to the advanced fingerling stages or to adults. The importance from an economic standpoint of securing information about the natural forage of very young fish is seen at once. So far as we know, only a small percentage of the fry reach maturity, and by more or less vague explanations the failure has been referable to our lack of knowledge of the food relations in their environment.

This investigation, conducted at the U. S. Fisheries Biological Laboratory, Fairport, Iowa, refers primarily to the aquatic vegetation in the food of fish which are reared in ponds and considers the problem from the following standpoints: What plants contribute directly to the food of the advanced fry and fingerlings? What plants contribute indirectly to their food by providing forage for the various animal forms upon which fish feed? The investigation covers the period of the summer months during two seasons, June 20 to August 31, 1917 and 1918.

The data presented illustrate the dependence of the young fish on food, mostly animals, which in turn feed on plants. The determination of these plants, which are the basic source of the food supply in the ponds, forms the chief contribution of this paper. Numerous examinations have been made of the food content of young fish, in which the direct use of plants by them is revealed. The results have been formulated into tables (p. 14) which supplement the data already at hand in the researches of Forbes (1880), Pearse (1918), Reighard (1915), and others, and indicate plant values among the flowering plants, the filamentous algæ, and various microscopic plants.

The method pursued has been to study the plant population and, correlatively, the contents of the digestive tract in various species of

young fish. An inventory (Table 1) was taken of the plant population in certain ponds,[a] covering all forms, the larger rooted aquatics, the floating forms, including the filamentous algæ, and the plankton. Simultaneously with the inventory an examination was made of the food found in the digestive tracts of the young fish taken from the ponds at regular intervals. By this means it has been possible not only to identify the food but to determine the character of the forage grounds of the fish and to consider the various plants and the animal associations of importance in the economy of the pond.

Collections of fish were made at weekly intervals and, if not examined at once in their fresh condition, were kept in an alcohol-formalin preserving fluid until needed. In examining the food the method of Pearse (1918) was employed, that is, the food content of the digestive tract was pressed out upon a glass slide, moistened, and examined under the dissecting and compound microscopes. All figures in the tables referring to food content represent volumetric percentage estimates. Measurements in lengths are given in millimeters and exclude the caudal fin.

A brief and general description of the ponds under investigation will assist in making the interpretation. The accompanying map from an earlier publication of the Bureau shows clearly the position and arrangement of the ponds at the Fairport station. They are grouped in six series, A, B, C, D, E, and F, respectively, the ponds in each series being numbered independently. The investigations here recorded were concerned only with series B and D, the former composed of six small, the latter of nine somewhat larger dirt ponds. The areas of the specific ponds studied, that is, 16B and 1, 2, 3, 8, and 9D, vary from 0.22 to 0.85 acre. Water is supplied to each through inlet pipes connected with a large reservoir, which in turn is supplied from the Mississippi River. The depth varies from about 6 inches near the inlet pipes to 7 or 8 feet at the outlet. Plants common to the ponds of the region have been introduced; marsh plants such as cat-tails, Sagittaria, Bidens, and Eleocharis occupy the shallower portions; sedges bind the borders of the deeper portions; and floating and rooted aquatics flourish within the pond area. Various aquatic insects and other animal forms have found their way into the ponds, and practically natural conditions prevail.

BASS, CHIRONOMID, AND ALGAL RELATIONS.

It is shown in Table 2 that the chironomid larvæ are among the most important single items of food taken by the young of the largemouth black bass during the summer. The larvæ of a certain species of the chironomids removed from the digestive tract were identifiable and later checked up with specimens taken from the ponds. These proved to be *Orthocladius nivoriundus* Fitch., a species common in the ponds and the one upon which the bass chiefly fed. The body walls of this larva are thin and transparent, and when lightly crushed under a cover glass the food content can be readily determined with the microscope. It was this identification of the alga in the crushed specimens taken from the bass that gave the clue to the chain of food relations subsequently to be described.

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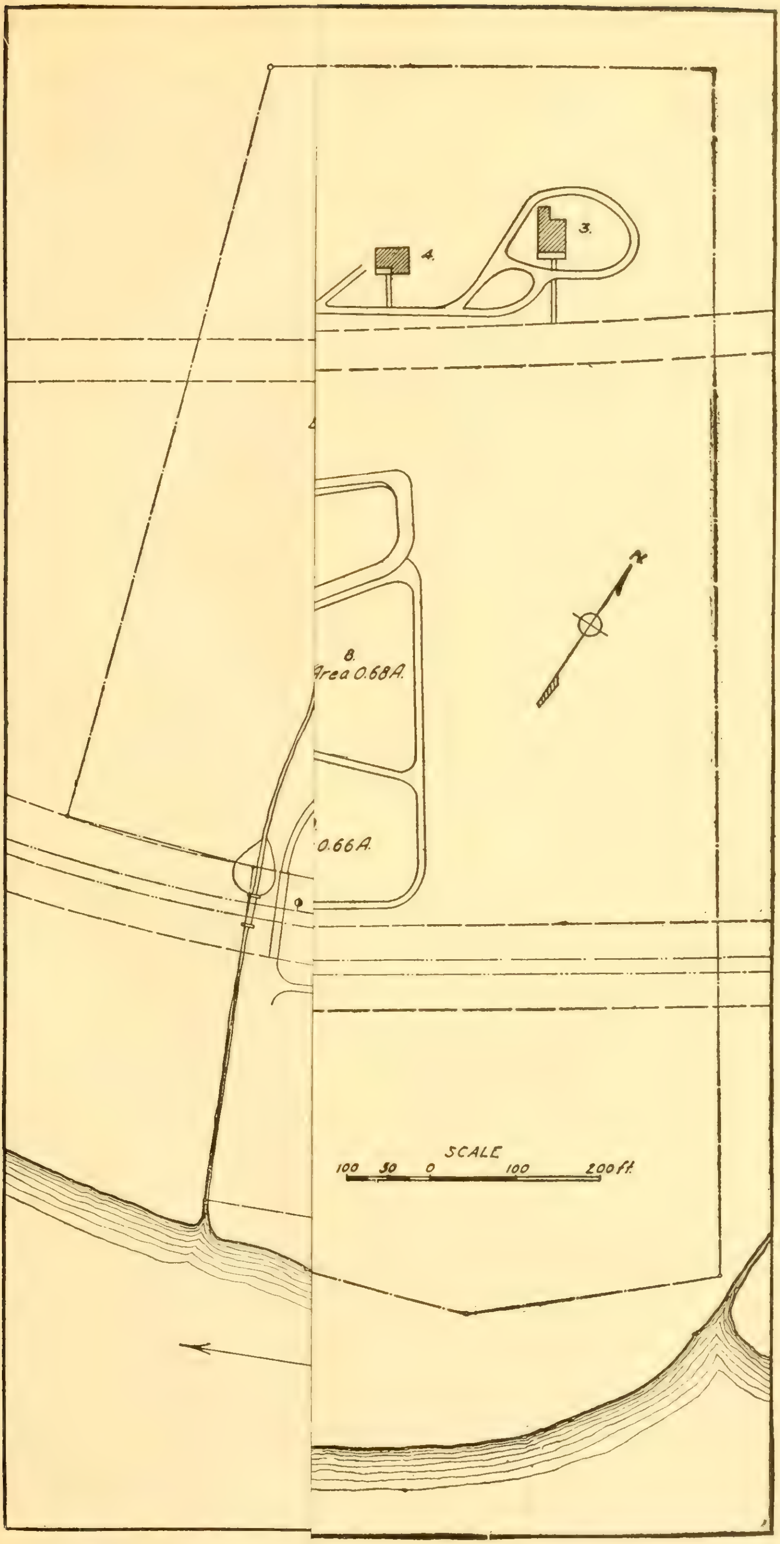
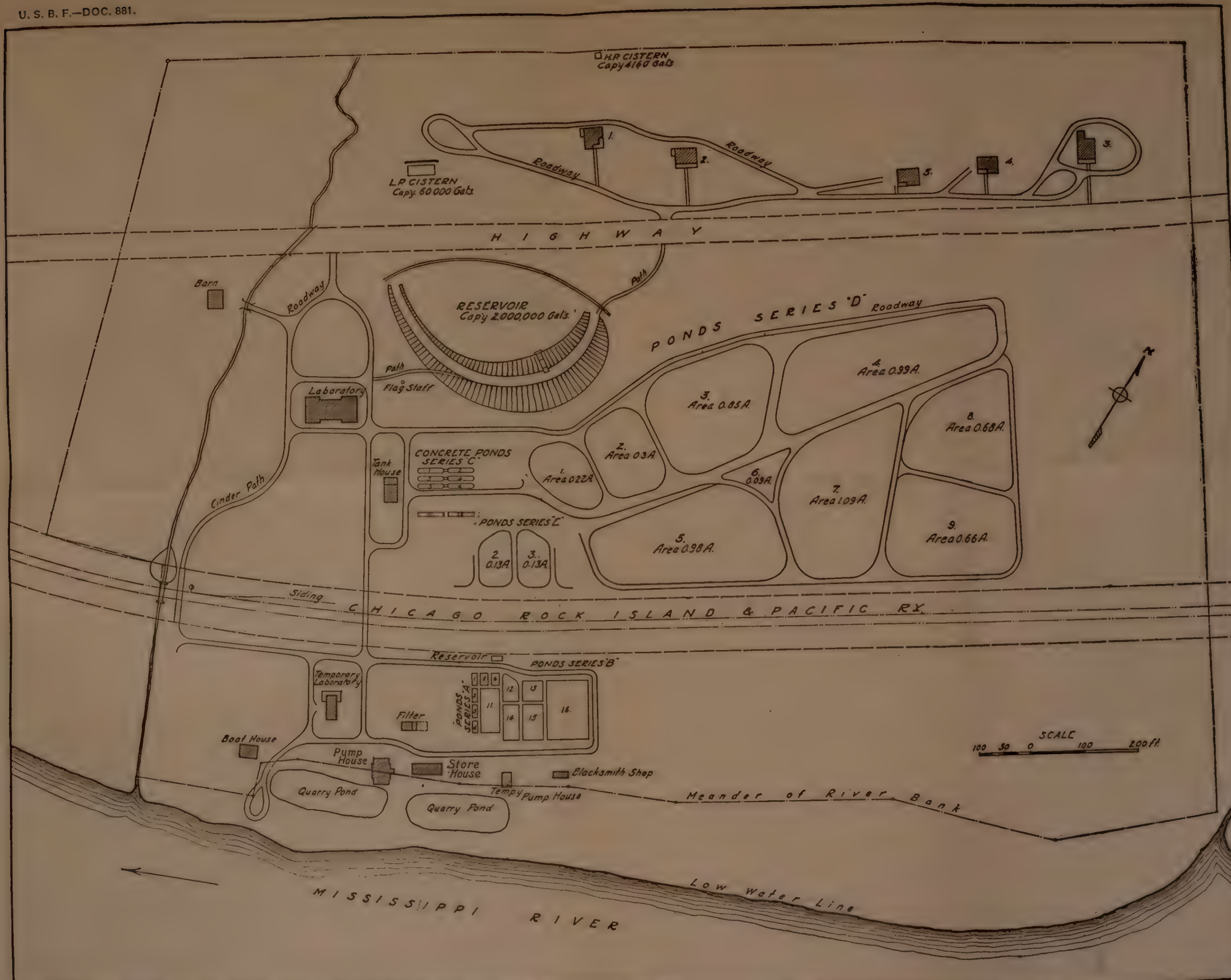
[a] See accompanying map showing topography of the ponds under investigation.


4.
3.
8.
Area 0.68A.
0.66A.
N
SCALE
100 50 0 100 200 ft.


H.P. CISTERN
Cap'y 4160 Gals
L.P. CISTERN
Cap'y 60000 Gals
Roadway
Roadway
1.
2.
3.
4.
5.
HIGHWAY
Barn
Roadway
Path
RESERVOIR
Cap'y 2,000,000 Gals.
PONDS SERIES "D"
Roadway
Path
Flag Staff
Laboratory
4. Area 0.99 A.
3. Area 0.85 A.
8. Area 0.68 A.
2. Area 0.3 A.
1. Area 0.22 A.
6. 0.09 A.
7. Area 1.09 A.
9. Area 0.66 A.
5. Area 0.98 A.
CONCRETE PONDS SERIES "C"
Tank House
PONDS SERIES "E"
2. 0.13 A.
3. 0.13 A.
Cinder Path
Siding
CHICAGO ROCK ISLAND & PACIFIC RY.
Reservoir
PONDS SERIES "B"
Temporary Laboratory
PONDS SERIES "A"
11.
12
13
14
15
16.
Filter
Boat House
Pump House
Store House
Blacksmith Shop
Tempy Pump House
Quarry Pond
Quarry Pond
Meander of River Bank
SCALE
100 50 0 100 200 ft.
Low Water Line
MISSISSIPPI RIVER
N

Previous to the identification of this chironomid in the fishponds the inventory of the plants had disclosed the interesting association of the larval stage of this insect with the alga, *Mougeotia genuflexa*. The alga was exceedingly abundant and produced a most remarkable and beautiful formation. This formation, or algal mat, as it may be called, was composed of delicate, light-green filaments of gossamer-like threads which were interwoven intricately in the form of loose-meshed rolls suspended near the surface of the water. The author's attention was attracted by a large number of elliptically-shaped bags, or cases, lightly held in the meshes of the algal mat. These proved to be the larval cases of the chironomid in question. While foraging for food the larvæ move in and out of their cases, retaining their hold, meanwhile, by their caudal hooks. In feeding they draw toward them filaments from the loose meshes of Mougeotia, or they forage directly from the outer walls of their cases, to which this alga is applied in the construction of the case, renewing the filaments as fast as they become depleted. The larvæ continue to feed upon this alga as long as the supply lasts, which is generally only until the middle of July, for by that time this species of alga, which flourishes during the early part of the season, has passed the stage when floating mats are readily formed. Thereafter it becomes scattered through the partial disintegration or breaking up of the filaments. It is at this time that the characteristic "knees" or swellings in the cells occur which give to this form of Mougeotia its specific name, *genuflexa*. It is while engaged in these feeding operations that the larvæ fall prey to the bass.

Several hundred larvæ of *Orthocladius nivoriundus* were examined to determine to what extent other algæ contributed to their food supply. The determination is a simple matter. The larvæ are lightly crushed under the cover glass by a slow, forward movement of the thumb, a slight pressure being sufficient to push out the contents of the digestive tube. The material is teased out under the microscope, and the problem becomes one of identification of the algæ. Almost without exception larvæ taken from the mats of Mougeotia showed a forage value of 100 per cent of this alga. From larvæ taken at random in pond 3D, from habitats in which other algæ were the chief constituents and Mougeotia appeared only as a small factor in the heterogeneous assortment, this alga again formed the bulk of the food. Specimens of *O. nivoriundus* were hatched in a watch glass to which had been added a variety of algæ as well as Mougeotia, and it is interesting to note that the young selected the latter invariably. It is not surprising, for Mougeotia is one of the most delicate of the filamentous forms and possesses a brittleness which apparently recommends it to the larvæ, for when observed in their feeding operations they were seen to snap off filaments in one-cell and two-cell lengths with great rapidity. This preference for Mougeotia was observed in the very earliest stages of larval growth, and it continued to be shown to pupation.

Later broods of *Orthocladius nivoriundus*, of which there appeared to be three during the summer, found their natural forage among other algæ which succeeded *Mougeotia genuflexa*, such as *Mougeotia sphærocarpa*, *Spirogyra nitida*, *S. majuscula*, Œdogonium, *Hydrodictyon reticulatum*, Lyngbya, and various microscopic forms present in the algal mats.

IMPORTANCE OF ALGAL MATS AS FORAGE.

The larva of the chironomid, *Orthocladius nivoriundus*, forms an important item in the dietary of the largemouth black bass. In turn the alga Mougeotia and other filamentous types supply forage for the chironomids. Thus these common pond plants contribute in a material way to the support of the bass.

Nearly all of the aforementioned algæ are commonly distributed in ponds. Where they do not occur and the region is within their range, they can easily be introduced into the ponds by transferring a roll or wad of the alga before it dries out. If the alga is to be transferred by mail it should be rolled in a wet cloth, wrapped in thick paper, and dispatched at once.

Unfortunately the notion exists that algal mats serve no useful purpose, and wasteful practices prevail in the seining operations. Without discrimination they are raked out, thrown upon the bank, and left to decompose, regardless of kind or function in the economy of the pond. The author's observations thus far on the value of algal mats, which may be called locally "moss," "moss blanket," or "water moss," lead to the conclusion that discrimination must be exercised if the ponds are to be properly stocked with useful forage plants. For help in such discrimination the species which commonly produce the algal mats, or "moss," floating on the surface of ponds, are given as follows: *Cladophora crispata*, *Hydrodictyon reticulatum*, *Pithophora œdogonia* var. *vaucherioides*, *Œdogonium martenicense*, *Rhizoclonium hieroglyphicum*, and Spirogyra species. Generally not one form alone produces the mat or blanket but a combination, as Cladophora and Pithophora; Hydrodictyon, Œdogonium, and Cladophora, etc.

Blankets in which Cladophora, Pithophora, and Rhizoclonium are the prominent forms appear to be least desirable, though the subject warrants further investigation. This blanket complex reproduces and forms a coarse, thick mat which readily covers a pond and shuts out the light. Under control, however, this mat may be regarded as useful. It should be conserved near the edges only.

FIELD CHARACTERS OF VARIOUS ALGAL MATS.

The following field characters will assist in discriminating the different kinds of algal mats or blankets:

Mougeotia genuflexa when abundant forms a loose, filmy, floating aggregation of delicate, light-green, gossamerlike threads lightly suspended near the surface of the water and easily wafted about by the wind. It is as difficult to scoop up in the hand as a floating spider web would be. This alga does not accumulate in sufficient quantity to become detrimental, since its filaments are so delicate and form so loose a mesh that light is not appreciably shut out by it.

Mougeotia sphærocarpa is also a delicate alga, though a little less so than *M. genuflexa*, and its growth habit is different. It has a light yellow-green frothy look and floats on the surface of the water as a thin film. It is found in the sheltered places usually, though it may spread over a small pond as a surface film when undisturbed by the wind. The frothy appearance is due to the very active photosynthetic capacity of the alga, the oxygen bubbles being confined,

meanwhile, in the meshes of the filaments. This alga compares favorably with *M. genuflexa* as a food producer. It appears in abundance in the ponds later in the season than the foregoing species and has been observed repeatedly in the examination of the larval food of Orthocladius, Pseudochironomus, and Stratiomyia.

Spirogyra species are generally a vivid green. They more often form a part of an algal complex, though they may occur nearly pure in round mats of varying size. They can be identified easily by the slimy, silky feel of the single threads or filaments. When held out of the water the single threads drip and curl up on drying. *Spirogyra weberi* may develop in a pure stand enveloped in a mass of transparent jelly.

Œdogonium martenicense often forms the upper layer on the mat of Cladophora. Upon aging, it fades to a pale yellowish color and acquires a soft cottony feel. Chironomids are active feeders upon it.

Œ. sp.[a] does not form a mat but occurs as an epiphyte on the larger aquatics and on the coarser filamentous algæ. The slender naias (*Naias flexilis*) and the water-weed (*Elodea canadensis*) may become completely swathed in it by midsummer. It is an extremely small form of Œdogonium which in the aggregate takes on an olive-green look. It has the characteristic cottony feel. All things considered, it doubtless affords forage to a greater number of pond herbivores than any other alga of the ponds. Chironomids, snails (Planorbis and Succinea), and the blunt-nosed minnows, as indicated by their food contents, show a preference for this alga.

Pithophora œdogonia var. *vaucherioides* consists of short filaments which on aging look and feel like coarse, dark hair. It is generally to be found with Cladophora and in the mat-forming stage occupies the stratum beneath it or becomes interwoven with it.

Cladophora crispata forms the coarsest and thickest algal mats in our ponds. The mats, or portions of them, have a coarse, heavy look and a harsh feel. When the mat is lifted out of the water it feels tough and gives one the impression of handling wet, coarse, brown paper or coarse loosely-woven cloth.

Hydrodictyon reticulatum, or water-net, is easily distinguished when floated out on the hand by means of the characteristic four to five sided meshes. It may form in sufficient abundance to produce a heavy mat covering the surface of small ponds.

These "rough and ready" field characters should assist the uninitiated in discriminating the most common and widely distributed representatives of the mat-forming algæ of our pond waters. It is recognized of course that the microscope, together with keys and illustrations, is the only sure method of identification.

BOSMINA AND VOLVOX ASSOCIATION.

The plankton studies in pond 2D showed a conspicuous association of the small cladoceran, *Bosmina longirostris*, and the green alga, Volvox, species *perglobator* and *spermatosphæra*. The association of these organisms. Bosmina and Volvox, is important in terms of fish food. The Bosmina afford a direct means of subsistence to the young bass; and the Volvox, through their contribution to the food supply of the Bosmina, an indirect one.

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[a] A valuable forage species unidentified to date but probably near *howardii*.

By reference to Table 2, it is seen that the young bass find in the small Bosmina a favorite natural food. It was selected by them from a varied and abundant zooplankton consisting of cladocerans, copepods, and rotifers. In the smallest fry examined the Bosmina content reached 100 per cent. For example, in the examination several specimens under the average of 12.2 mm. measured 10 mm. and 11 mm., and in all cases, the smaller the fry taken from the environment of Volvox, the larger the percentage of Bosmina in the food content, indicating that this is not only the earliest but the preferred natural food of the young bass.

It was found that Bosmina occupied the upper stratum of water in the open areas as well as the more sheltered weedy portions of the ponds. Their presence is indicated to the naked eye by the appearance, as it were, of a fine sprinkling of dust particles continually gyrating in the surface film of water. They occur in the greatest numbers just below the surface, and in this location they are accessible to the fry as they rise to feed.

The Volvox accumulated also in the upper stratum of water. The pulse of this alga coincided with that of Bosmina, but declined before any distinct diminution of Bosmina was noted. Further observational studies disclosed the direct dependence of Bosmina upon Volvox for subsistence.

Plankton catches from the upper stratum were taken repeatedly, and the feeding habits of Bosmina observed under the compound microscope. It was rarely possible to identify the food once taken into the digestive tract, because in most cases the mandibles grind the food particles beyond recognition. Occasionally, however, particles slip by whole, and when these could be seen through the transparent body walls the animal was lightly crushed under a cover glass to make the identification more sure. Bits of broken cœnobia of Volvox were identified, and these graded into the ground material characteristic of the digestive tract. In most cases the feeding habits were observed directly by watching the maneuvers of the living animal. Volvox was in the reproductive stage, and organisms with antherozoids, or sperms, were exceedingly abundant. The Bosmina in their feeding operations attached themselves to a bundle of ripe antherozoids, and by a rapid movement of the legs, characteristic of all cladocerans, winnowed the sperms within the body walls, from whence they were wafted into the mouth. This continued until the bundle of antherozoids was appreciably diminished, and the Bosmina whirled off to other feeding grounds, in which the constituents were often too small to identify as they were wafted into the body. Volvox, however, continued to remain a source of nutriment until its decline.

This interdependence of the organisms, Bosmina and Volvox, was observed in pond 1D also, but the plankton pulse was not manifested by so large a quantity of Bosmina in this pond.

SCAPHOLEBERIS AND MOUGEOTIA ASSOCIATION.

It was found that *Scapholeberis mucronata*, a larger cladoceran, succeeded the Bosmina in the food of the older fry, and investigation followed to determine its food relations among the algæ of the ponds.

Plankton catches showed a larger percentage of Scapholeberis in pond 1D than in all others. Attention was then concentrated upon this pond. Plankton studies were made from various regions in the pond to determine the specific plant habitat of the cladoceran. This proved to be the scum or film produced by the alga, *Mougeotia sphærocarpa*, in the quieter portions of the pond. In these regions the algal complex teemed with Scapholeberis, the feeding grounds being conspicuously localized in the region of the Mougeotia filaments.

The examination of the food content in the digestive tracts of Scapholeberis revealed a miscellaneous diet of small unicellular and palmelloid algæ which abounded in the Mougeotia complex. The most common forms were small diatoms, and such green algæ as Sphærocystis, Oöcystis, Cælastrum, and Schizochlamys.

The association of this cladoceran with the Mougeotia complex adds another point in favor of the introduction and cultivation of Mougeotia to supply a natural forage in fishponds.

The Scapholeberis pulse in pond 1D attained its maximum in late July and early August. At that time it supplied a fair percentage of the food of the largemouth black bass (Table 2) and a high percentage of the food of the bluegill (Table 3).

Ponds 1D and 2D have differed in the contribution they made to the food supply of the young fish in the matter of quantity as well as variety. This was particularly true of the Bosmina pulse which occurred in both ponds simultaneously but to a lesser degree in pond 1D. Birge and Juday (1911) state: "The answer to the question of why different bodies of water differ so widely in productivity is wholly beyond our knowledge." In these ponds, however, a partial explanation may be sought in the difference in kind and quantity of living plants as well as in the accumulations of débris during succeeding seasons.

In physical features the ponds are similar. They are equally deep, and they are surrounded by a similar vegetation. They have been treated alike, that is, they have been wintered full, not dry. Such draining as has been necessary to conduct the seining operations has been temporary only. Physiologically, however, they are more or less distinct because of the dissimilar character of the vegetation in them. Pond 1D has been richly stocked with floating algæ which at times have covered the surface. Few of the larger rooted aquatics are present. Pond 2D has no algal mats or blankets, but fully one-tenth of the surface area has been covered by the large-rooted aquatic, *Potamogeton illinoensis*, interspersed in places with the nonrooted Ceratophyllum, or hornwort. In these ponds are present, apparently, the requisite conditions to produce a conspicuous plankton pulse of great economic value in terms of the natural forage of fish fry by supplying in quantity organisms which are preferred by the fry during the early days of feeding.

DAPHNIA AND APHANIZOMENON ASSOCIATION.

Data in the tables show that a high percentage of food is supplied by the daphnids. They are recognized herbivores in the ponds, and it remains to explain their particular plant preferences and associations.

A remarkable illustration of such an association was presented during the present season in the studies connected with pond 9D, in which *Daphnia pulex*, one of the largest of the daphnids, was produced in enormous quantity by natural means. The blue-green alga, *Aphanizomenon flos-aquæ*, contributed directly to its support and proved to be the most desirable food of a heavy, natural culture of *Daphnia pulex.*

The author's first observation of this association in the pond occurred on June 21, 1918. At this time a "bloom" of the Aphanizomenon was approaching its maximum. It was so abundant that the water appeared blue-green and oily. A few hand strokes of the dip net would bring up a quart of it in concentrated form. The individual colonies are ordinarily microscopic, but during the acceleration of growth in "bloom" production the colonies are considerably augmented and become readily distinguishable. They appear as flocculent masses, 7 to 16 mm. long and less than half as wide. They are delicate and tissuelike and assume the form of flattened spindle-shaped masses lightly suspended in the water at all depths, from the surface to the bottom of the pond. Practically a pure stand had developed, for there were few representatives of other floating algæ present. The station records noted the presence of the algæ in May. From that time until June 21, the date of the author's first observation, multiplication must have taken place with great rapidity, and it continued to do so until the maximum was reached in the interval of July 24 to 30, when the algæ could be rolled up from the bottom like mush.

This conspicuous growth of algæ in the pond was attended by one equally remarkable in the number of Daphnia produced. The Daphnia swarmed among the algæ, forming practically a pure culture of *Daphnia pulex*. A rough estimate by volume, obtained by the gravity method, showed approximately 75 cc. per cubic meter. Accurate determinations were difficult because of the accompanying algal débris in the concentrations. When the algal maximum was attained the Daphnia pulse had already begun to decline. Cypris, copepods, and rotifers increased in the zooplankton and Clathrocystis, Volvox, and Pleodorina in the phytoplankton.

The daphnids fed continuously upon the Aphanizomenon. The entire process of feeding could be observed easily by placing them in a watch glass or in a hollow glass slide and observing them with the compound microscope. The flocculent masses of the alga were wafted into the open walls of the body and fed forward toward the mouth by the action of the legs in the manner so aptly described by Birge (1918). During the feeding operations the Daphnia were offered a mixed plankton, but invariably they retained only the Aphanizomenon in the food current streaming toward the mouth. Observations on the feeding habits were continued from time to time during a period of five weeks, and it was easily seen that the abundant natural forage provided in Aphanizomenon was one of the determining factors in the high productivity of *Daphnia pulex.*

By reference to Tables 4 and 5 it is seen that Daphnia formed a high percentage of the food content in the orange-spotted sunfish and catfish with which the pond was stocked. Data are not at hand for the very young catfish since it was desirable not to disturb the ponds

by seining during the breeding period, but the large size of the fingerlings (Table 5) at the date recorded seems worthy of note and readily explainable in terms of an abundance of desirable natural food.

The succession of causes, physical and physiological, which have led to the remarkable acceleration of growth in the alga, Aphanizomenon, and the accompanying culture of daphnids is not easy to explain; yet it is desirable to record the method of treatment of the pond which has produced this extraordinary development. The pond covers an area of 0.66 acre and is free from floating plants. In the shallow portions there are submerged aquatics such as Naias and *Potamogeton pusillus;* and around the edge, a little of the blanket-forming alga, *Cladophora crispata.* In general it is an open pond free from the larger aquatics or their accumulations. It could easily have become "seeded down" by spores of Aphanizomenon through inlet waters from the supply reservoir which in turn receives the river water. This alga is common in the supply waters and is distributed in season to the ponds. *Daphnia pulex* are also common in the ponds. A contributing cause of the great "wave" of Daphnia is possibly due to the fact that the pond has been wintered dry during successive seasons, the freezing and drying processes affecting the winter eggs of the daphnids beneficially.

MAYFLIES IN THE FOOD OF BASS.

Reference to Table 2 indicates the importance of mayfly larvæ in the food of the young largemouth black bass. The mayflies are herbivores. The researches of Needham (1905), Morgan (1913), and Clemens (1917), on the life histories of these insects have shown that they subsist on a variety of plants in our lakes and streams, the familiar articles of diet being diatoms, unicellular and filamentous algæ, and the larger aquatic plants, the latter generally in a partial state of disorganization. Unfortunately, time has not permitted investigation of the plant associations of this group of insects in small ponds. From the few records of examination, however, it may be forecasted that an important habitat preference of some species of the larvæ is among the larger potamogetons.

THE DIRECT FUNCTION OF PLANTS IN FISHPONDS.

The tables show a forage value of plants which can not be regarded as merely accidental. By reference to Table 7 it becomes evident that the young of the buffalofish favor an admixture of animal and plant substance. The absence of grit in the digestive tract and the presence of plant materials, such as the staminate flowers of Elodea, for example, which are found only at or near the surface of the ponds, illustrate the wide range of their feeding habits. The high percentage in the food content of the flagellate plants, Pandorina, Eudorina, and Pleodorina, is suggestive of the value of the small things among the pond plants.

The most conspicuous function of plants in the fishpond is found in their indirect relations, in their contribution to the forage of myriads of animal forms upon which fish feed. This paper has emphasized this function of plants in its consideration of animal-

plant associations, and it is through a more complete understanding of such associations that the method of rationing the ponds to increase their productivity by natural means can be approached.

SUMMARY.

1. Chironomid larvæ are among the most important single items in the dietary of young bass.
2. The identification of the food content and plant associations of the chironomids indicates the importance of cultivating certain algal forms in the ponds to provide adequate forage requirements.
3. Mat-forming algæ of certain types provide valuable forage areas for chironomids and cladocerans.
4. The Bosmina-Volvox association is of special importance in providing the first forage materials for the bass fry and the young bluegill.
5. The Scapholeberis-Mougeotia association is important in providing a later food for the advanced fry stage.
6. The Daphnia-Aphanizomenon association develops a heavy culture of daphnia.
7. Plants are of importance directly in supplying a high percentage of food to the advanced fry of the buffalofish.
8. The blunt-nosed minnow in a pond habitat subsists mainly upon plants.
9. The rationing of ponds for a continuous and abundant supply of natural forage must depend upon a more precise knowledge of the animal and plant associations.

TABLES.

[NOTE.—All figures in the tables referring to food content represent volumetric percentage estimates. Measurements in lengths are given in millimeters and exclude the caudal fin.]

TABLE 1.—INVENTORY OF AQUATIC PLANTS IN CERTAIN PONDS OF SERIES B AND D, FAIRPORT, IOWA.[a]

[P means present; A means present in abundance.]

Aquatic plants.	June, 1917.					June, 1918.
	Pond 1D.	Pond 2D.	Pond 3D.	Pond 8D.	Pond 16B.	Pond 9D.
Flagellates: Euglena sanguinea		P			P	P
Blue-green algæ:						
Aphanizomenon flos-aquæ			P	P		A
Microcystis				P	P	
Clathrocystis						A
Cœlosphærium		P	P	P		
Merismopedium				P		
Oscillatoria	P		P			
Lyngbya martensiana				P		
Anabæna circinalis						P
Anabæna flos-aquæ		A			P	P
Rivularia natans			P	P	P	
Diatoms:						
Navicula	A	P	P	P	P	P
Synedra	P	P	P	A	P	A
Pleurosigma				P		
Cocconeis	P	P	A	A		A
Melosira		P		P	P	P
Tabellaria fenestrata	A	A				
Fragilaria		P	P			
Gomphonema		A				
Amphora	P					

[a] Inventory not exhaustive but sufficiently detailed to serve as a working basis.

TABLE 1.—INVENTORY OF AQUATIC PLANTS IN CERTAIN PONDS OF SERIES B AND D, FAIRPORT, IOWA—Continued.

Aquatic plants.	June, 1917.					June, 1918.
	Pond 1D.	Pond 2D.	Pond 3D.	Pond 8D.	Pond 16B.	Pond 9D.
Green algæ:						
Cosmarium pyramidatum	P		P	P	P	A
C. undulatum	P	P	P	P	P	P
C. notibile						P
Closterium moniliferum	P		P	P		
C. lanceolatum			P	P	A	A
C. lunula				P		
Staurastrum polymorphum		P	P	P	P	P
Selenastrum		P			P	
Zygnema sp		P	P			
Spirogyra communis	P	P	P			
S. porticallis		P	P			
S. varians			A	P		
S. decima			P			
S. nitida	P	P				
S. crassa	A	P	A		P	
S. tenuissima	P	P	A			
S. gravilleana				P		
Mougeotia genuflexa			A			
M. lætevirens			A			
M. sphærocarpa	A					
Chlamydomonas				P		
Pandorina morum		P		P	A	P
Pleodorina californica				A	A	P
Eudorina elegans	P	P	P	P	P	
Volvox perglobator		P	P	P	P	P
Volvox spermatosphæra						
Palmella		P	P			
Botryococcus			P			
Ineffigiata				P		
Tetraspora		P				
Anchistrodesmus		P				
Scenedesmus		P		P		P
Hydrodictyon reticulatum			P	A		
Pediastrum duplex	P	P	P	P	P	
Ulothrix			P		P	
Œdogonium rivulare	A	A		P		
Œ. sp	A	A	A			A
Œ. martenicense	A		P			
Cladophora crispata	A	P	A		P	P
Rhizoclonium hieroglyphicum			A			
Pithophora œdogonium var. vaucherioides	A	P	A			P
Chara			P			
Flowering plants:						
Typha latifolia	P	P	P	P		P
Sparganium americanum	P	P				
Potamogeton illinoensis		A	P			
P. pectinatus			P		A	
P. pusillus			A	P		P
Naias flexilis	P	A	A	A		A
Sagittaria latifolia		P	P	P	P	
Elodea canadensis	P	A	A	A		P
Vallisneria spiralis		P	P			
Lemna minor	P			P		
Heteranthera dubia			A		P	
Ceratophyllum demersum	P	A				
Nymphæa advena					P	
Castalia odorata			A		P	
Ranunculus aquatilis	A	A	A			
Myriophyllum spicatum			P			

TABLE 2.—FOOD CONTENT OF LARGEMOUTH BLACK BASS (MICROPTERUS SALMOIDES), ADVANCED FRY AND FINGERLINGS, IN CERTAIN PONDS AT FAIRPORT, IOWA.

Date.	Pond.	Specimens.	Average length.	Animals.								
				Cladocerans.								
				Bosmina.[a]	Scapholeberis.[b]	Miscellaneous forms.	Cypris.	Copepods.	Nauplii.	Rotifers.	Chironomid larvæ.[c]	Chironomid adults.
1917.		No.	Mm.									
June 28	3D	[e]3	20	......	......	......	......	......	......	......	97.3	......
1918.												
July 5	3D	2	31	......	5	25	......	5	......	......	42	......
July 11	3D	5	31.5	......	......	63.5	4				10	......
July 18	2D	16	12.2	60	6	13.3	......	1.2	3.1	1.2	16.8	0.9
Do	3D	6	33	......	......	7.1	......	2.5	......	......	18.3	......
July 25	1D	5	42.7	......	6.2	......	6	2	......	......	33.4	......
Do	2D	3	31	13.3	......	8.3	......	35	......	......	16.7	......
Do	3D	15	36.9	......	......	26	.1	.7	......	......	15.4	......
Aug. 4	3D	5	41.5	......	......	6	......	2	......	......	30	......
Aug. 8	3D	4	43	......	......	12.5	......	10	......	......	67.5	......
Aug. 10	3D	5	43.2	......	......	16	3	6	......	......	18	......

Date.	Animals—Continued.								Plants.				
	Beetle larvæ.[d]	Mayfly larvæ.	Damselfly larvæ.	Dragonfly larvæ.	Adult flies.	Water mites.	Caddice larvæ.	Unidentified material.	Various unicellular algæ.	Volvox.	Œdogonium sp.	Pithophora.	Naias flexilis.
1917.													
June 28	......	......	......	......	......	......	......	2.5	......	......	......	......	......
1918.													
July 5	......	20	......	......	......	......	......	2.5	......	......	......	......	......
July 11	5	8	......	......	......	5	......	......	......	......	......	......	......
July 18	......	1.2	......	......	......	......	......	......	1.2	......	......	......	......
Do	......	4.2	2.5	5	4.2	......	......	56	......	......	......	......	......
July 25	5	16.4	12	19	......	......	......	......	......	......	......	......	......
Do	......	......	......	......	26.7	......	......	......	......	3.3	......	......	......
Do	44.3	4.8	6	......	......	......	......	.6	......	......	......	......	1.6
Aug. 4	25	30	......	......	......	......	......	7	......	......	......	......	......
Aug. 8	10	......	......	......	......	......	......	......	......	......	......	......	......
Aug. 10	2	28	......	......	......	......	14	......	......	......	2	8	3

a Bosmina and Volvox association.
b Scapholeberis and Mougeotia association.
c Chiefly Orthocladius and Cricotopus sp., Tanypus decoloratus Mall, and Pseudochironomus richardsoni Mall. The identifications of chironomids were made by Dr. R. A. Mutkowski and Dr. O. A. Johannsen.
d Mainly Dytiscid beetles.
e From H. F. Schradieck's unpublished reports. The larvæ in the food content were identified as Orthocladius nivoriundus. The algæ upon which these chironomids had fed consisted of 100 per cent Mougeotia genuflexa.

TABLE 3.—FOOD CONTENT OF BLUEGILL (LEPOMIS PALLIDUS), ADVANCED FRY AND FINGERLINGS, IN CERTAIN PONDS AT FAIRPORT, IOWA.

Date.	Pond.	Specimens.	Average length.	Animals.								
				Cladocerans.								
				Bosmina.	Scapholeberis mucronata.	Miscellaneous forms.	Adult copepods.	Nauplii.	Cypris.	Chironomid larvæ. [a]	Damselfly larvæ.	Mayfly larvæ.
1918.		No.	Mm.									
July 25	2D	10	12.4	66.9	......	11.1	......	10	......	11	......	......
Do	1D	18	18.9	9.4	17.2	28.4	31.1	......	0.6	9.2	......	......
Aug. 1	2D	25	13.4	43.6	......	19	9	6.1	.8	13.8	......	......
Do	2D	17	15.6	49.9	......	12.4	12.4	......	.6	15.2	......	......
Aug. 8	1D	5	36.9	4.5	......	52	12.6	......	4	11	2	5

Date.	Animals—Contd.				Plants.								
	Beetle larvæ.	Water mites.	Rhizopods.	Unidentified.	Unicellular algæ.	Anabæna.	Diatoms.	Volvox.	Desmids.	Mougeotia.	Spirogyra.	Œdogonium.	Spores.
1918.													
July 25	......	......	......	......	......	......	......	1	......	......	......	......	......
Do	1.4	......	......	......	......	0.3	......	......	......	1.3	0.3	0.3	......
Aug. 1	......	......	0.6	0.8	0.4	......	0.3	4.4	......	.5	.6	......	......
Do	......	......	......	3.2	......	......	1.4	......	0.6	......	......	1.2	2.9
Aug. 8	......	2	......	3	......	......	......	......	......	1	......	3	......

a Chiefly Tanypus decoloratus Mall and Pseudochironomus richardsoni Mall.

TABLE 4.—FOOD CONTENT OF ORANGE-SPOTTED SUNFISH (LEPOMIS HUMILIS), ADVANCED FRY AND FINGERLINGS, IN POND 9D, FAIRPORT, IOWA.

Date.	Specimens.	Average length.	Animals.											Plants.	
			Cladocerans.												
			Daphnia pulex. [a]	Chydorus.	Miscellaneous forms.	Diaptomus.	Miscellaneous copepods.	Cypris.	Chironomid larvæ.	Notonectids.	Beetle larvæ.	Unidentified.	Hyalella.	Œdogonium sp.	Plant debris.
1918.	No.	Mm.													
July 15	2	30.5	19.5	......	......	......	......	......	80.5	......	......	......	......	......	......
Do	1	71	10	......	......	......	......	10	30	......	50	......	......	......	......
July 18	5	18.6	39	......	6	9	15	......	25	......	6	......	......	......	......
July 25	12	25.6	31.9	18.4	.8	12	19.5	.9	16.1	......	......	......	......	......	......
July 26	16	22.5	52	6	1.5	.9	27.3	......	6.5	3.1	......	0.6	0.9	0.6	......
Aug. 2	19	23.3	27.1	20.4	......	18.4	25.6	......	4.2	......	......	4.2	......	......	......
Aug. 8	10	42.5	6	5.1	......	3	14.5	12	57.5	......	......	.4	......	......	2

a Daphnia and Aphanizomenon association.

TABLE 5.—FOOD CONTENT OF CHANNEL-CAT (ICTALURUS PUNCTATUS), FINGERLINGS, IN POND 9D, FAIRPORT, IOWA.

Date.	Specimens.	Average length.	Animals.							
			Daphnids.	Chydorus.	Copepods.	Cypris.	Chironomid larvæ and pupæ.	Damselfly larvæ.	Notonectids.	Beetle larvæ.
1918.	No.	Mm.								
July 25	2	51.5	37.5	......	20	2.5	30	......	......	7.5
Aug. 2	6	54.1	3.8	13.3	2.5	4.2	28.3	3.3	2.5	2.3
Aug. 16	6	58.3	4.2	17.5	5.8	2.2	58.3	......	......	......

Date.	Animals—Contd.			Plants.					
	Hyalella.	Leeches.	Grit, débris, etc.	Clathrocystis.	Diatoms.	Volvox.	Closterium sp. Cosmarium sp.	Œdogonium sp.	Elodea.
1918.									
July 25	......	......	12.5	......	......	......	......	......	......
Aug. 2	7.5	15.8	13.3	......	......	1.2	......	1.66	......
Aug. 16	......	......	5.8	3.3	0.83	......	1.7	......	0.33

TABLE 6.—FOOD CONTENT OF BLUNT-NOSED MINNOW (PIMEPHALES NOTATUS) IN CERTAIN PONDS AT FAIRPORT, IOWA.

Date.	Pond.	Specimens.	Average length.	Animals.						Plants.	
				Daphnids.	Chironomid larvæ.	Anurea cochlearis.	Statoblasts of pectinatella.	Insect débris.	Grit.	Phacus.	Euglena.
1918.		No.	Mm.								
July 26	9D	1	49	5	......	......	......	......	......	......	......
Aug. 7	9D	2	46.5	......	......	17.5	7.5	......	47.5	......	......
Aug. 8	8D	9	45.1	6.7	......	4.4	.55	1.1	4.4	3.9	......
Aug. 15	8D	4	46.2	1.3	5	......	......	......	27.5	1.75	0.75

Date.	Plants—Continued.										
	Chroococcus.	Oscillatoria.	Lyngbya.	Anabæna.	Spirulina.	Diatoms.	Schizochlamys.	Closterium sp. Cosmarium sp.	Œdogonium sp.	Naias flexilis.	Elodea.
1918.											
July 26	......	......	......	......	......	5	......	10	80	......	......
Aug. 7	......	......	......	2.5	......	......	5	20	......	......	......
Aug. 8	4.4	1.1	28.9	6.7	7.2	3.3	5	2.8	......	3.3	15.5
Aug. 15	......	......	55	......	5	1.25	......	2.5	......	......	......

TABLE 7.—FOOD CONTENT OF BUFFALOFISH (ICTIOBUS BUBILUS AND I. CYPRINELLA), ADVANCED FRY AND FINGERLINGS, IN POND 16B, FAIRPORT, IOWA.[a]

Date.	Specimens.	Average length.	Animals.							Plants.		
			Arcella.	Difflugia.	Cladocerans.	Rotifers.	Statoblasts of Plumatella.	Insect eggs.	Chironomid larvæ.	Blue-green algæ.	Ceratium.	Diatoms.
1917.	*No.*	*Mm.*										
July 12	7	12	......	......	5	20.2	......	......	1.2	0.6	......	5.5
July 24	20	19.9	3.1	15.2	7	3.8	......	1.3	3.1	3.1	......	3
Aug. 24	15	29.6	6.2	25.8	6.8	12.2	0.1	......	1.1	6.4	2	3.2

Date.	Plants—Continued.											
	Euglena.	Volvox.	Pleodorina.	Eudorina.	Pandorina	Pediastrum.	Scenedesmus.	Desmids.	Œdogonium sp.	Staminate fls. of Elodea.	Grit.	Débris.
1917.												
July 12	7.1	......	5.1	15.4	30.6	1	......	8	0.1	......	0.1	......
July 24	.1	......	15	2	3	......	......	4.2	1.5	19.8	9	6
Aug. 24	......	0.1	31.3	......	......	......	0.1	2.8	.2	.3	1.2	......

[a] Fry hatched in jars May 17 to 22, 1917, and transferred to pond May 25, 1917.

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SOME CONSIDERATIONS CONCERNING THE SALTING OF FISH

By Donald K. Tressler

Temporary Assistant, Division of Fishery Industries

Appendix V to the Report of the U. S. Commissioner of Fisheries for 1919

CONTENTS.

SOME CONSIDERATIONS CONCERNING THE SALTING OF FISH.[a]

By Donald K. Tressler, *Temporary Assistant, Division of Fishery Industries.*

Contribution from the Fishery Products Laboratory, Washington, D. C.

INTRODUCTION.

THE NEED FOR EXPERIMENTAL WORK.

Although fish have been preserved with salt since prehistoric times, little experimental work has been done with the view of improving the existing methods. The fisherman who salts his own catches of fish or who cooperates with his neighbors in salting fish has neither the time nor the money to experiment that he may improve his product or save labor and waste products. With a few exceptions, the fishing industry has not attracted large capital for extensive operations. It has not been exploited, therefore, as has the meat-packing industry.

Much work has been done in the hatching of fish eggs, stocking streams and lakes, and increasing the aquatic life of this country generally. But until recently little had been done to conserve the fish after being taken or to utilize as food fish which had hitherto been neglected. Little of the river herring, sea trout, Spanish mackerel, kingfish, sea bass, scup, and drumfish in our southern waters had been utilized until within recent years, when refrigerator cars and cold-storage plants came into use.

It required the stimulus of the enormous demand for food caused by the great world war to awaken an interest in fish salting and to arouse a demand for better methods. It became apparent that if the methods of salting fish could be improved so that fish might be salted with safety during hot weather in any warm climate the food-fish supply of the United States would be greatly augmented.

[a] This work was undertaken in cooperation with the National Research Council, Council of National Defense, and was at first conducted in the laboratories of Johns Hopkins University, where the author had the benefit of the advice and direction of Prof. B. E. Livingston, department of plant physiology, and Prof. E. V. McCollum, School of Hygiene and Public Health. He is also indebted to Prof. J. J. Abel, of the department of pharmacology of the same university, for the use of his laboratory for the conduct of part of this work.

The results achieved, the conclusions reached, and the recommendations made in this paper have their origin in experiments done on a small scale and are not to be taken as having been proved by commercial practice.

There is a lamentable lack of control over the salt-fish product produced in any plant. In some places the standard of quality is a white, colorless fish. Yet in those localities it is doubtful whether the fish salters understand the factors controlling whiteness. In other localities a very hard, rigid fish is desired. In such regions there is a great demand for Turks Island salt, for it is quite generally understood that this salt produces a hard fish, although very few understand why. Before this experimental work had been followed two weeks the experimenter learned that the qualities of the finished product, such as color and hardness, could be controlled entirely. This alone made the work worth while.

It has long been known that it is exceedingly difficult to salt fish in the ordinary way during hot weather, and few attempt it. Apparently no one had tried to find out why fish spoil so quickly while being salted during the summer.

For centuries fish have been cured either in brine or in dry salt without the addition of brine. There has been much discussion concerning the value of the two methods. It was, therefore, worth while to determine the relative merits of the two methods of applying salt to fish, even though no information relevant to the problem under consideration should be obtained.

The inexactness of the present methods has been pointed out to show the need for such experimental work as is reported in this paper. Correct interpretations of experimental work should lead to more exact procedure in salting fish. A more uniform product should be obtained. The results of the experimental work should explain the reason for some of the methods in use to-day. The consideration of the scientific aspect of fish salting should bring forth a spirit of research for better salt fish. There should be a demand for high standards for salted fish. At present in some parts of the country the salt-fish buyers have practically no standards for estimating the quality of the salt-fish product. This is in part because of the difficulty in estimating differences in quality of salt fish.

At the present time (summer of 1919) the price of salt river herring is very low. This is chiefly because the quality of salted herring sold during the past few years has been so poor. The salt river herring on the market has a very strong " wild-game " taste. If certain precautions were taken, this could be entirely avoided. The resultant product would then be of much better quality than that to which the public is accustomed. It is doubtful if a better price could be obtained for salt river herring under present conditions. If higher standards were demanded, however, it should sell for a higher price.

In North Carolina and Virginia the buying public has become so accustomed to purchasing very hard, dry fish that soft fish in brine will not sell, although it may be better in quality. There is little ground for the argument that dry, hard fish is of greater culinary value. On the other hand, without investigation it would seem reasonable that a wet, soft fish would be more palatable when cooked than a fish " as hard as a board."

Most fish salters are aware of the fact that they must not store their fish in hot places during the summer months; yet no attempt has been made to determine the best conditions for storing salted fish. Fish have been stored both dry (" tight packed," packed in layers

with solar salt between layers of fish) and in brine (pickle); yet no investigation has been carried out to show which of these two methods is the better. The "tight-pack" method is almost universally used in the South, whereas in the North fish, with the exception of cod, haddock, cusk, and pollock, are just as universally stored in brine.

Much may be done to improve both the methods of salting and of storing fish. If better methods were used, salted fish, even the "common herring," would regain its place in public favor. The fish salter would gain immensely thereby, for as the quality improves so will the demand. It is hoped that this work may be the beginning of a movement looking toward a better salted-fish product; that it may encourage the fish salter to control his product and produce a fish of the best possible quality. A proper understanding of the factors affecting the product will surely lead toward the improvement of methods.

PRESENT COMMERCIAL METHODS OF SALTING FISH.

The methods of salting fish in use to-day vary greatly in different localities. The writer found, in going from one fish-salting plant to another, that many fish salters were not familiar with all of the methods of salting fish. It is wise, therefore, to give a brief description of the methods in use in various parts of the country. This will make clear the reasons for the procedure followed in the experimental work. There may also be a better understanding of these different methods, and if they are correctly understood the fundamental principles of salting fish will be clear to the reader.

In this work no mention is made of the mechanical details of cleaning, hauling, lifting, or drying fish. Attention is given to only the important points which affect the quality of the finished product. The writer has visited five fish-salting centers and has observed the methods employed. The procedure followed in salting fish in these places will be described briefly. No attempt has been made to include all of the different processes or the procedure for all varieties of fish. The description merely includes the most important methods and the general procedure.

GLOUCESTER, MASS.

In Gloucester the business of salting fish is very extensive. It is characterized by greater organization and larger companies than elsewhere. The reason for the organization is to be found in the large number of fish caught in that vicinity and in the continuity of the catches. Fish are brought into Gloucester in large quantities every working-day of the year. Employees may, therefore, be hired for the entire year and the plants worked on a larger scale than elsewhere.

The cod, haddock, cusk, and pollock are caught together and are salted in the same general way. When they are unloaded from the vessels, the fish are sorted as to kind and size. During the cold months these fish are salted either in kenches (regular piles or layers of fish) or butts (very large barrels, of about 300 gallons capacity). In the warmer months all are salted in butts, as the fish would spoil

if they were not covered with pickle during the "striking" or salting process. The fish are thrown "face up" (cut surface, flesh side up) into the butts and sprinkled with salt as they are thrown in. Great stress is placed upon the even distribution of the salt. Between 6 and 7 bushels are used to each butt of fish. Turks Island salt is ordinarily used. Each butt yields approximately 500 pounds of dried cod. The rule holds: The warmer the weather the more salt used.

The fish are piled high above the top of the butt. The last few layers, those exposed, are piled with the backs up. A pile of salt is placed upon the top of the fish. By the day following the salting, the fish have settled below the top of the butt and the pile of salt has almost disappeared. Five or six more pecks of salt are then added to strengthen the pickle. Ordinarily the fish are allowed to remain in the butts from 10 days to 3 weeks. Only 3 days are required for the salt to penetrate through the fish, the remainder of the time being required for the fish to "strike through," or harden. After 3 days the flesh of the fish is still quite soft, but during the next 18 days it gradually becomes harder. If there is a large supply of fish on hand and if the demand is slack the fish are left in the butt much longer than 3 weeks. However, if allowed to remain there for too long a time the salted fish become yellow. This happens in the space of 2 months or less in hot weather, but in cold weather the fish may be left in the butts almost indefinitely. The amount of salt added (6 or 7 bushels) is far in excess of the amount actually taken up by the fish and dissolved in the pickle. This excess salt is used later in making more pickle.

After the fish are "struck" they are taken out of the butts, the slime is washed off, and the fish are piled in kenches about 4 feet high, face up, with the exception of the last few layers, which are piled face down in order to keep the top layers clean (free from dust). Weights are placed on top of the kenches to compress the fish and to squeeze out the pickle. Since the object of the kenching is to allow the fish to drain and partially dry, they are piled on racks about 8 inches above the floor. This enables the pickle to run out from under the piles of fish. The length of time during which the fish are left in the kenches depends mainly upon the weather and upon the amount of fish already upon the flakes. (See below.) During warm weather the fish are likely to spoil, so they are watched very closely and are repiled whenever there is danger of spoilage. The more often the fish are repiled the less time they must remain on the flakes; but the fish salters usually do not repile them more than once, since it requires a great deal of time. However, if the season is a rainy one, and they do not dry rapidly upon the flakes, the fish are rekenched several times.

After the fish are somewhat dry they are placed upon flakes for further drying. A flake is a rack (a lattice bed about 8 feet wide) built in the open, about 30 inches above a floor. The drying yard is known as the flake yard and is often located on a roof. The degree to which the fish are dried depends upon the trade. If the fish are to be sold in the southern States, they must be drier than if they are to be sold in the immediate vicinity. The length of time the fish must remain upon the flakes to dry to the required degree depends entirely upon the weather. The lower the humidity, the less time is

required for drying. The higher the velocity of the wind, the more rapidly the fish dry. When there is a driving wind two or three lots may be dried in a single day. When the weather is poor, however, it may take a week or more to dry a single lot. If the sun is hot, great care is taken to prevent the fish from becoming sunburned. Canvas is placed a few feet above the flake, and this prevents the direct-burning action of the sun. When the day is too hot, the fish are not placed upon the flake. If rain is imminent, they are collected and put under waterproof boxes on the flakes.

After drying, the fish are sorted as to quality and size. A first-quality fish should be uniformly white, have no bloodstains, possess a "sweet" smell, and be one of the thicker fish. After the fish are sorted they are hauled to the packing room. Before packing they are sprinkled with salt containing 0.4 per cent boracic acid, the amount of this mixture applied depending upon the climate of the region where the fish will be sold; the warmer the climate, the more of it used. This sprinkling of the dried fish with boracic-acid mixture is peculiar to this class of fish. No other salt fish is piled in kenches or dried on flakes. If the fish is for export, it is tied in bundles and packed in boxes or drums.

Although the method of cleaning, the cut appearance of the various fishes, and the amount of salt used all differ, mackerel, whiting, alewives, and herring are usually salted by the same general method in Gloucester. The exact procedure followed in salting one particular fish varies with the season and the trade, however.

The cleaned (cut) or round (uncut) fish are dipped in salt, the fineness of the salt and the quantity used depending upon the variety of the fish and the season of the year. The dipped fish are packed in layers in barrels or butts, salt is scattered over each layer, and, as in the case of cod, a small pile of salt is placed on top of the fish. The fish are then allowed to make their own pickle, and within 24 hours enough has been formed to cover them. The pile of salt on top of the fish is replenished on the second day.

Ample time is allowed for the fish to become thoroughly "struck," or salted, before they are touched again. This period is usually at least 30 days. The fish are then repacked tightly in barrels. In most cases a small amount of salt is placed over the top. The barrel is then headed and a bunghole bored in it, after which it is rolled on its side and filled with 100° brine (saturated salt solution).

REEDVILLE, VA.

Along the Chesapeake Bay, in the vicinity of Reedville, Va., there are about 40 fish-salting plants. Almost the only fish salted on a large scale is the alewife, or river herring. There is little organization among the fish salters of this region, due, in part, to the very short season. At Irvington the plants often operate no longer than six days. At Reedville the plants operate for about three weeks; however, the rush season lasts only a week.

The packers in this vicinity salt fish in a way distinctly different from that used in any other section of the country, with the exception of Havre de Grace, where for the most part, a similar method is used. The washed, cut river herring are dumped into large vats filled

one-sixth full with 100° pickle (saturated salt solution). As the fish are placed in the tanks salt is scattered over each layer. Each day the fish are roused (stirred up) with large paddles and more salt is added, usually in sufficient quantity to make the pickle saturated (100°); but the procedure varies in the different plants. Some fish salters (those in the vicinity of Irvington) keep their brine at 70 per cent saturation (70°). Even if the brine used at the start is saturated, by the following morning, when the fish are stirred for the first time, the pickle is not stronger than 60°. If a very large excess of salt is added when the fish are put in, this lowering of the concentration of the salt solution may be obviated to a considerable extent; but, as the fish are immersed loosely in a large excess of pickle, there is a tendency for the salt to sink to the bottom of the vat. As a result the pickle on top is always below saturation, whereas the bottom layers are saturated, or very nearly so.

At the end of from 7 to 10 days the fish are scooped out of the vats and hauled to a draining floor, where they are placed loosely in piles about 18 inches deep. They are allowed to drain and dry for three or four days. Then the salted river herring are packed tightly in layers in barrels, and a quart of Turks Island salt is scattered between each two layers of fish. No brine is added to these barrels, as the fish are sold dry. It is to be noted that in this region brine is added to the fish when they are salted, and after salting they are sold dry; whereas in Gloucester the alewives are salted with dry salt, without the addition of brine, and are sold in brine (pickle).

EDENTON, N. C.

Most of the fish salted in this region are river herring, or alewives. Most of the fishermen salt their own catches of fish. The fish-salting plants are, therefore, small, even smaller than those in the vicinity of Reedville. The season here is also short, usually lasting about six weeks.

In this region greater care is taken to wash the cut (cleaned) fish more perfectly. As a result, the salt river herring produced is of a little better quality than that produced elsewhere. The fish are mixed with salt with shovels and are shoveled into butts without any particular packing. They are allowed to remain in the butts from 8 to 12 days, after which they are piled on the floor to dry and drain for three or four days, in the same way that they are handled at Reedville. They are then packed tightly in barrels. About a quart of Turks Island salt is scattered over each layer of fish; no brine is added.

HAVRE DE GRACE, MD.

In Havre de Grace practically the identical procedure is followed in salting fish as in Reedville, Va. Aside from one plant, in which some fish are salted by a modified "Scotch" method, there are no important differences from the Reedville method. This modified "Scotch" method involves the salting of the round (uncut) alewives with dry salt. The fish are packed tightly in barrels, covered, and allowed to develop their own pickle. This method is similar to the one followed at Boothbay Harbor. However, at Boothbay Harbor

the fish are "gibbed" or "pipped." That is to say, the gills are cut out, and the viscera, with the exception of the roe or milt, are pulled out. The fish are sold in brine.

BOOTHBAY HARBOR, ME.

Herring is the principal fish packed in Boothbay Harbor. Most of the fish are Scotch-cured here. In this process the pipped fish are mixed with fine salt by hand without being washed. They are then carefully packed in barrels. Salt is sprinkled over each layer. A day or so later the barrels are filled up with herring of the same day's pack. After 9 or 10 days the barrel is drained of the old pickle, and the fish are washed with it without unpacking. The barrel is then completely filled with fish and filled through the bunghole with 100°, or full-strength, brine. The peculiarity of this method is that the fish are not washed before being salted. Therefore, every bit of blood in the cut fish either remains in the fish or goes into the pickle.

SUMMARY.

As stated previously, no effort has been made to include all the variations of the different methods of salting fish. Neither has any attempt been made to discuss any detail other than the mode of applying the salt to the fish. From the above description it is seen that all the methods include but three general modes of application of salt to fish: 1. The fish are immersed in a solution of salt which is kept saturated, or nearly so, by the addition of salt from day to day. 2. The fish are packed in water-tight containers with dry salt and are allowed to develop their own pickle. 3. The fish are packed in piles (kenches), and the pickle is permitted to run off the fish as it is formed.

The last-mentioned method is used only in cold weather, in an emergency when there are no containers at hand. Such is often the case on ships fortunate enough to make extraordinarily large catches. As it is practical only in cold weather, the method is not available for much commercial fish salting, and therefore no experimental work with it has been attempted.

The brine method of salting fish is chiefly used along the Chesapeake Bay, in the Reedville (Va.), and Havre de Grace (Md.) regions. This method has the big disadvantage of requiring more labor than the dry-salt method. Some salt must be added nearly every day, and the pickle must be watched closely to prevent it from becoming too weak. The fish must be roused (stirred up) every day. This is done with large paddles of various sizes and shapes and requires the expenditure of considerable energy. The fish produced by this method are much softer and contain more water than those produced by the dry-salt method. They appear similar to partially "struck," dry-salted fish. However, the fish are more plump and seem more like fresh fish than the dry-salted product.

The dry-salt method involves no rousing after salting and necessitates but one addition of salt, provided the fish are properly salted in the beginning. Usually the fish salted by this method are tightly packed in barrels or butts and not disturbed. This prevents the salt from falling to the bottom, as is the case when the brine-salted fish

are roused. Fewer scales are knocked off, and the fish have a wrinkled, shrunken appearance. If a lot of dry-salted fish is mixed with a lot of brine-salted fish, the fish can easily be separated, so marked is the difference in their appearance.

STORAGE OF SALTED FISH.

There are three general methods of storage: 1, the brine; 2, dry, with salt; 3, dry, with boracic acid. The quality of the fish on the retail market depends to a considerable extent upon the temperature and method of storage. No experimental work on storage was done.

The fish are kept in their own pickle or put in fresh saturated brine, or packed dry. If the pickle formed by the fish is dirty in appearance, it is discarded and fresh pickle (salt solution) is added. New brine is always added if the salt fish are likely to be stored in a place which is not cool. Fish dealers say that the "blood pickle" is likely to "sour" if kept in a warm place.

If the fish are packed dry, as are the cod in Massachusetts and the alewives in the South, they are packed either with salt or with boracic acid. The cod is sprinkled with salt containing 0.4 per cent boracic acid before packing. A considerable quantity of coarse salt is thrown over each layer of alewives as they are packed in the barrels.

In all cases the salted fish must be kept at a low temperature if they are to be stored for any length of time. The fish salted in Massachusetts and Maine are held in cold storage until the time of shipment. In North Carolina and Virginia the fish are held in "cool storage." Fish stored exposed to the air are very likely to "rust." Rusting is due to the oxidation of the fish oil and gives the fish a dark-brown color. Packing in brine prevents this to a large extent.

PURPOSE OF EXPERIMENTAL WORK.

This work was instituted in order to work out, if possible, a method of salting fish applicable in warm climates. At present none of the methods known are applicable for commercial purposes in a climate where the temperature averages above 70° F. Great care must be taken if the mean temperature rises above 60° F. The logical way to work out any new method is to study the existing methods first. This study should show whether some method in use to-day can be so improved that it may be used at a higher temperature. If, after the present procedures have been given a trial and their shortcomings discovered, no existing method can be adapted for warm climates, then the need for a new method will be shown.

FACTORS INFLUENCING THE SALTING OF FISH.

At the beginning it was evident that, if the various methods were to be fairly judged, the influence of the factors affecting the salting of fish would have to be known. Then, if all known methods were found incapable of being modified for use at higher temperatures, the relative values of the various factors would have been found, and improvements in the present methods might be suggested without further work. There would also be a basis of knowl-

edge with which a new method could be worked out. Besides, this plan of procedure would give data of great value. The application of correct interpretations of these data would lead to improved methods and a more uniform product. The relative importance of the factors influencing the salting of any fish being then known, the fish salter should be able to produce any desired product by modifying his conditions.

It has always been known that the relative freshness of a fish has an influence upon the quality of the salted fish. Everyone is aware of the fact that if fish are stale great care must be exercised in salting them in order to obtain a desirable product. There are no data in the literature which show how stale a fish may be and yet be salted satisfactorily. This result depends upon the efficiency of the method.

Any method that may be used to salt fish at high temperatures may also be used to salt stale fish. Since there is so little control of the present method of salting, little valuable data on this process could be obtained unless the available methods of salting fish were standardized so that uniform procedure would be followed in all cases.

Commercial fish salters are often very careless in allowing their fish to become stale before they salt them. The writer found it necessary to obtain the maximum temperature of salting perfectly fresh fish. Evidently the thoroughness of cleaning and washing the fish has an influence on the temperature at which they can be salted and also on the quality of the product. It is a well-known fact that unbled animals have a "wild-game" taste. The chief difference between the taste of domestic ducks and wild ducks is due to the fact that wild ducks are shot and not properly bled, whereas domesticated ducks are carefully bled. Fish salters are well aware of the fact that more care must be taken in the salting of round or uncut fish than in curing cut fish. Blood, milt, and roe are substances which decompose readily. Is it not possible that the presence of these substances in fish lower the maximum temperature at which they can be salted?

In the description of methods it was mentioned that there are three ways of applying salt to fish. The kench method of dry salting can be used in only cold weather. Prior to these experiments no one had shown which of the other two methods was the better during hot weather. In Massachusetts the dry-salt method is used the year around; yet in Virginia the fish salters are firm advocates of the brine method.

The resistance of the skin to the penetration of salt is another factor of importance in salting fish. Almost every fish salter will inform you that the salt penetrates more rapidly through the cut surface of the fish than through the skin. Would it not, then, be feasible to skin the fish before salting in warm weather?

Different modes of procedure are followed when various kinds of fish are salted. This in itself is evidence that the species of the fish is an important factor to be considered when working out any method of salting fish. The amount of fat in the different species of fish varies greatly—from about 0.09 per cent in cod to about 16.2 per cent in fat mackerel. The fat in a fatty fish might alter the

permeability of a fish to salt. The fat of different fishes varies widely in chemical composition and physical constants. Some fats may spoil more readily than others and thus affect the keeping qualities of the fish. Fish of different species vary in chemical composition. Everyone knows that some fish soften and spoil much more readily than others. Fish of the same and different species vary greatly in size. The surface exposed to the salt depends upon the size and shape.

MODE OF PROCEDURE IN EXPERIMENTAL WORK.

The chemical changes which fat undergoes during salting and storage were not studied, so that any points presented on this subject are merely casual observations which the experimenter noted during his work. The writer used but four species of fish in this work; naturally, therefore, it is not certain that the work applies to all varieties of fish. Most of the work was done with the squeteague (*Cynoscion regalis*) and the alewives (*Pomolobus æstivalis* and *pseudoharengus*). No marked differences were observed in the changes taking place during the salting of these fish. The writer ventures the opinion that the rules observed as to the protein decomposition (flesh decomposition) will apply to nearly every species of fish; but he doubts whether any observations concerning the chemical changes occurring in the fat of one species will hold good for all others, for the various fat constants of the oil of different species vary considerably. The rate of oxidation of these fats would vary nearly as much as the composition, because certain fish oils are much less saturated than others and would oxidize much more readily.

With the exception of the chemical changes taking place in the fat and the fact that the species studied were few in number, the writer believes that he has covered in this paper all of the most important factors influencing the salting of fish. The two factors not studied in detail embrace such a large amount of work that they were considered as separate problems.

Few important chemical investigations concerning the salting of fish have been carried out. Previously the problem had been considered mainly from the bacteriological standpoint. Various investigations concerning bacteriological problems had been attempted, but no methods of estimating the rate of salting, the rate of protein decomposition, or the freshness of fish were to be found in the literature. The investigator had, therefore, to work out and standardize methods applicable for his purpose. This in itself was no small task. The writer does not claim that the methods used are perfect or that other procedures could not be used to better advantage but rather admits that they may be improved upon. However, the procedure was uniform, and the results obtained checked satisfactorily in most cases. They must, therefore, be accepted as relative if not exact.

It seems obvious that the more rapidly salt penetrates the flesh of the fish the sooner decomposition of the tissue will stop. This statement is based on the assumption that decomposition of the tissue ceases when the fish is thoroughly salted. But this is not exactly the case. Decomposition is not stopped; it proceeds almost

infinitely more slowly. The decomposition products are also changed in nature, but no toxic compounds are developed. Later the salted fish may spoil because of unfavorable storage conditions, but it is not likely that the spoiled fish will produce harmful results if eaten. In order, therefore, to learn how fast salt penetrates a fish, a method was required which would enable the experimenter to determine the rate of penetration. This should enable him to judge, at least from one standpoint, the value of different salts.

The rate of penetration of salt into fish was followed by cutting sections of the fish at different depths from the surface. These sections were ashed and the amount of chlorine in them determined. The amount of chlorine in the dry salt fish was then calculated. This was done from day to day, and thus the increase in salt content of the inner sections was determined. The rate of penetration of any salt into fish is not an absolutely accurate criterion for judging the quality of that salt, for certain impurities in the salt might have a preservative action surpassing that of the salt.

Then it was necessary for the experimenter to learn the best method of cleaning fish preparatory for salting and to judge the necessity of absolute freshness. The rate of penetration does not afford a means of judging between two methods of application of the salt. It was necessary, therefore, to choose some means of estimating the decomposition of the flesh of fish and to adapt it for use with salt fish. A wide choice was not permissible, for a very large number of determinations must be run simultaneously and quickly. The apparatus required had to be simple and easily transported, as it was necessary to take the laboratory to the fish, as it were, in order to obtain fresh fish. The estimation of the rate of amino-acid formation was chosen as an indicator of the rate of protein decomposition. The reasons for this choice will be explained further on.

A limited amount of histological work was carried on in order to determine if possible the difference between the effect on the cell structure of the salted fish of pure sodium chloride and of sodium chloride adulterated with other chlorides. A complete record was kept of the macroscopic changes of each lot of fish. All the ordinary qualities were observed, such as color, odor, hardness, brittleness, taste, and general appearance. For the sake of brevity only the most notable changes are recorded in this paper. All edible samples of salted fish were cooked at the end of the experiments and their palatability noted. In these culinary experiments the fish were cooked in such a way that their flavor was in no way disguised.

The writer presents in this paper only those conclusions that seem to him to have been proved beyond doubt. The results may be accepted as facts for the river herring and the squeteague. It is very probable that they hold for other fish, but further work must be done to prove this point beyond doubt. In no case are the figures absolutely exact; but there is little doubt that they are relative to each other and that they may be compared with confidence. The writer hopes that this research will create such an interest in the chemistry of fish salting that other researches of a similar nature will be instituted.

EXPERIMENTAL.

I. INFLUENCE OF IMPURITIES IN SALT IN SALTING FISH.

INTRODUCTION.

Nearly every fish salter is a firm advocate of the use of some brand of commercial salt. A few fish salters realize that the foreign solar salts produce fish of a quality different from the domestic vacuum pan salts, but nearly all of these fishermen think that the difference in the product is caused by the variation in the size of the salt grains. Very few think that the impurities in the salt affect the hardness, whiteness, and other properties of the salted fish. Only a few salters understand the real meanings of the trade names by which the salt is sold. Many believe that "ground alum" refers to the quality of the salt sold under that name and would be surprised to learn that this name refers merely to the fineness of the salt.

Fishermen say: "That grade of salt rots fish." The action of the salt on fish is not clearly understood by all fish salters and salt dealers. This work on the influence of impurities is worth while, even if it merely explains the effects of the common impurities in salt. This will give the fish salter some criterion for judging the value of the various salts.

COMMERCIAL SOURCES OF SALT.

The greater proportion of the salt used in this country previous to the war was solar salt prepared in Europe or in the West Indies. Most of this European salt is made by evaporation of sea water along the coast or on islands in the Mediterranean Sea. The chief reason for the use of this salt is the cheapness of transportation facilities from those parts of the world to the Atlantic seaboard, where most of the European salt used in America is consumed. A great deal more material is exported from the United States to Mediterranean ports than is imported from these ports. Steamers are very anxious to bring cargoes from the Mediterranean Sea to the Atlantic ports, and therefore they are willing to transport the salt to our shores for a very small price.

However, during the war this supply was almost cut off. The price of salt in the United States rose to a very high figure, and the greater proportion of the salt used was domestic. Fish salters who had previously been prejudiced against the use of American salt were forced to use it, and many of them became convinced that it was equal in quality, if not superior, to foreign solar salts.

METHODS OF MANUFACTURE.

Domestic salt is prepared by one of the following processes: Steam evaporation, vacuum evaporation, direct-heat evaporation, or solar evaporation.

Most of the salt produced in the eastern part of America, close to the regions where fish are salted, is manufactured by steam evaporation. The product produced by this method, in jacketed kettles, grainers, and vacuum pans, is a fine-grained salt. For some reason there is much prejudice against the use of fine-grained salt for fish salting. Because of this prejudice very little salt produced in this way was used by fishermen previous to the war. During the war, when the supply of coarse-grained salt was limited, a large proportion of the fish salters began the use of fine-grained salt partially to replace the coarse-grained salts.

The salts produced by direct-heat evaporation are usually coarser grained than those produced by steam evaporation. To-day this process is seldom used except where it is possible to utilize waste heat, and since such a small amount is prepared in this way, this method of production is not considered an important factor in the salt supply.

Unfortunately for the fish trade, nearly all of the domestic solar salt is produced in the arid regions of the West. The only place in the East where this method of evaporation is practiced is in the vicinity of Syracuse, N. Y. Because of the very high freight rates eastward across the continent, the cost of the western solar salt on the Atlantic coast is almost prohibitive.

Pure salt is pure sodium chloride. There is no brand of commercial salt on the market that is 100 per cent pure. There are, however, salts on the market which are 99.95 per cent pure. Most of the American salts are of greater purity than the foreign salts; however, there are a few British salts of great purity. The limited analytical data available to the author indicate that British salts, with the exception of Turks Island are, on the whole, of much greater purity than French, Spanish, and Italian salts. The reason for this probably is to be found in the method of manufacture. The southern European salts are mainly solar salts, whereas the British salts, because of the climate, must be prepared in some other way.

The ordinary procedure in the preparation of solar salts is to allow sea water at high tide to run, or be pumped, into low-lying lands, forming ponds. The outlet to the sea is then closed, and evaporation is allowed to proceed. As the brine becomes more concentrated and more nearly saturated it is run into other ponds. Finally, when the saturation point has been reached the brine is run into crystallizing ponds. Here the usual procedure is to allow evaporation to proceed until the brine becomes high in magnesium chloride and low in sodium chloride. Usually when a concentration of 32° B. is reached the mother liquor is drained off and discarded. From the above brief description of the process it will be seen that solar salt is likely to be impure. Since sea water is high in calcium and magnesium chlorides, it is likely that solar salt will be high in these constituents if it is crystallized but once.

ANALYSES OF COMMERCIAL SALTS.

The following are analyses of various typical commercial brands of salt:

ANALYSES OF VARIOUS SALTS USED FOR CURING FISH.[a]

Determinations.	Italian salt, Trapani.[b]	Spanish salt, Iviza.[b]	Domestic salt, Diamond Flake.[c]
	Per cent.	*Per cent.*	*Per cent.*
Sodium chloride	95.82	98.05	99.78
Calcium chloride	.32	.49	....
Calcium sulphate	....	....	.37
Magnesium chloride	1.19	....	.00
Magnesium sulphate	1.75	.80	.00
Sand	.15	.06	.00

[a] The sulphates were all calculated as magnesium sulphate and the calcium as chloride, except in the case of Diamond Flake salt, where no magnesium was found. In this case the sulphate was calculated as calcium sulphate.

[b] These results were calculated to a moisture-free basis from the data in the table, page 18, Bitting, A. W., Bureau of Chemistry Bulletin No. 133.

[c] Analyst, J. F. Stephl.

ANALYSES OF SAMPLES OF SALT.[a]

[Per cent on moisture-free basis.]

RADICALS.	Domestic salts.			Imported salts.						
				England.				Bahama Islands.	
	California: 23606-H, Leslie bulk salt from barrels, Leslie Salt Refining Co.[b]	New York: 11309-H, solar rock salt bulk, Solar Salt Co., Syracuse.[c]	West Virginia: MD-16102, Liverpool Salt Co., Hartford.[d]	P-8036, Ashton Higgin & Co., Liverpool.[e]	CN-2684, Chas. Moore & Co., Liverpool.[f]	France: P-7917, Bonaire Salt Exp. Co.[g]	Spain: P-8657, Pela Emprexado Navagacoa, Lisbon.[h]	P-7853, D.F. & H.F. Harriott, Turks Island.[i]	B-9015-16, Alfred Slotts Estate, Turks Island.[j]
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Arsenate (AsO_4)				Slight trace.	Trace.		None.	None.	
Tetraborate (B_4O_7)	None.			None.	Trace.	(?)	Trace.	None.	Trace.
Sulphate (SO_4)	0.021	1.365	0.00	0.89	Trace.	1.692	1.727	1.72	0.403
Carbonate (CO_3)					.000		.000		
Bicarbonate (HCO_3)					.031		.013		
Chloride (Cl)	60.70	59.51		59.81	60.63	58.51	59.34	59.44	60.16
Iron (Fe)			.007						
Calcium (Ca)	.025	.598	1.33	.39	.000	.764	.471	.45	.167
Strontium (Sr)			.81				.008		
Barium (Ba)			.67						
Magnesium (Mg)	.000	.000	.29	.02	Trace.	.090	.396	.47	.022
Sodium (Na, calculated)	39.34	38.56		38.73	39.34	37.71	38.02	37.97	38.98
Silica sand, etc. (SiO_2)	.008	.06		.02	.015	1.312	.086	.13	.293
Total	100.09	100.09		99.86	100.02	100.08	100.06	100.18	100.03

[a] Analyses supplied by and published by permission of the U. S. Bureau of Chemistry.
[b] Collected Sept. 5, 1914; analyst, W. F. Baughman.
[c] Collected Sept. 8, 1914; analyst, W. F. Baughman.
[d] Collected from Grainer May, 1913; analyst, W. F. Baughman. This salt is not supposed to be used for food purposes.
[e] Collected Feb. 4, 1916; analyst, C. H. Badger.
[f] Collected Oct. 6, 1914; analyst, R. H. Kellner.
[g] Collected Dec. 1, 1915; analyst, W. F. Baughman.
[h] Collected July 11, 1917; analysts, W. F. Baughman and R. H. Kellner.
[i] Collected Nov. 1, 1915; analyst, C. H. Badger.
[j] Collected Nov. 10, 1915; analyst, W. F. Baughman.

ANALYSES OF SAMPLES OF SALT—Continued.

	Domestic salts.			Imported salts.					
				England.				Bahama Islands.	
	California: 23606-H, Leslie bulk salt from barrels, Leslie Salt Refining Co.	New York: 11309-H, solar rock salt bulk, Solar Salt Co., Syracuse.	West Virginia: MD-16102, Liverpool Salt Co., Hartford.	P-8036, Ashton Higgin & Co., Liverpool.	CN-2684, Chas. Moore & Co., Liverpool.	France: P-7917, Bonaire Salt Exp. Co.	Spain: P-8657, Pela Emprexado Navagacoa, Lisbon.	P-7853, D. F. & H. F. Harriott, Turks Island.	B-9015-16, Alfred Slotts Estate, Turks Island.
COMBINATIONS.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Sodium chloride ($NaCl$)	100.01	98.02	[a]92.70	98.45	99.96	95.86	96.63	96.52	99.09
Sodium bicarbonate ($NaHCO_3$)					.043		.018		
Magnesium chloride ($MgCl_2$)			1.13	.08		.35	.967	1.20	.08
Magnesium sulphate ($MgSO_4$)							.737	.80	
Calcium chloride ($CaCl_2$)	.045	.08	3.68	.05		.16			
Calcium sulphate ($CaSO_4$)	.030	1.93		1.26		2.40	1.602	1.53	.57
Strontium chloride ($SrCl_2$)			1.46						
Strontium sulphate ($SrSO_4$)							.017		
Barium chloride ($BaCl_2$)			1.02						
Ferric oxide (Fe_2O_3)			.01						
Silica sand, etc. (SiO_2)	.008	.06		.02	.015	1.312	.086	.13	.293
Total	100.09	100.09	100.00	99.86	100.02	100.08	100.06	100.18	100.03
Moisture	.159	1.12	5.66	.84	.139	1.39	4.475	4.19	.31
Remarks	Fine crystals.			Fine crystals.		Coarse crystals.	Coarse crystals.	Coarse crystals.	Large crystalline lumps.

[a] By difference.

These analyses are given in order to show the large amounts of impurities contained in some salts and to point out that it is possible to purchase on the market salts that are very nearly pure. It is to be noted that the chief impurities are calcium, magnesium, and sulphates. It is not known in just what chemical combination these occur in the salt, but this makes no difference. The analyses are given on a moisture-free basis in order that they shall be relative to each other. Further, the amount of moisture contained in salt is of little importance to the fish salter; except that, of course, damp salt contains less salt per ton than dry salt and, therefore, is more expensive if it is purchased at the same price.

INFLUENCE OF IMPURITIES ON RATE OF PENETRATION OF SALT.

INTRODUCTION.

Former work on rate of penetration.—Bitting (1911), of the Bureau of Chemistry, tried some experiments to show the effect of fineness of salt upon the rate of penetration of salt into codfish. Bitting's data show that in various coarse and fine salts there was little difference in the rate of extraction of water from the tissues or in the rate of penetration of salt into the fish. However, in his work no consideration was given the chemical composition of the salt. To make the work comparative, a single salt ground to different degrees of fineness would have to be used in salting all of the experimental lots of fish. Bitting used various domestic and foreign salts which were of different degrees of fineness, but which varied widely in chemical composition. It is stated that the cod used were small in size, but no information was given regarding the uniformity of size, which is a very important factor, as salt will penetrate to the center of a thick fish much less readily than it will penetrate a thinner fish. Nor does Bitting give any information as to his method of obtaining a 50-gram sample from a fish. Before the experiments could be repeated the exact size of the fish used would have to be known and also the exact method of sampling. The writer doubts that any method of sampling a fish other than sampling a section of given thickness a definite distance from the skin or flesh side of the fish would be accurate enough to show differences in the penetrating powers of different salts.

Importance of rate of penetration.—A consideration of the cause of souring had suggested that the souring is a decomposition of the inner meat of the fish before the brine strikes through and stops the decay. Various writers had observed an antagonism between the bivalent metals and monovalent metals in their passage through membrane. This suggested that the small amounts of calcium and magnesium, which exist in commercial salt as impurities, might exert a pronounced retardation on the penetration of the sodium chloride into the fish. An attempt was, therefore, made to measure the influence of these metals on the penetration of the sodium chloride into fish. If it were found that these impurities in salt caused the salt to penetrate more slowly, then the use of purer salt would lessen the danger of spoilage, for the fish would strike through more rapidly and less time would be allowed for decay of the inner portion.

An attempt was, therefore, made to measure the rate of penetration of pure salt into fish as compared with the rate of penetration of mixtures of sodium chloride with the common impurities in salt; that is calcium, magnesium, and sulphate.

METHOD.

It was fortunate that the writer began his experiments on the rate of penetration of salt with chemically pure sodium chloride, for this led to the discovery that the impurities in salt were largely responsible for the physical characteristics of the salted fish. The fish chosen for this work was the squeteague or weakfish (*Cynoscion regalis*), which could be obtained in a nearly fresh condition almost all the year around in Baltimore, where the experimenter was working. This fish is of medium fatness and was obtained on the market in quantity at any desired uniform size. It had been planned to try any improvement that might be worked out on the alewife or river herring. The squeteague was more similar to the river herring than any other fish that could be purchased throughout a long season.

After considering many possible methods of determining the rate of penetration of salt into fish it was decided to determine the per cent of chlorine in different sections of the fish from day to day. The layer from one half to 1 cm. in depth was found by experience to give the most uniform results.

Thus far the work has been applied to but one fish, the squeteague. The writer does not claim that the results of the work on this one fish can be applied without change to all varieties of fish. Different results might be obtained if a fat fish, such as the mackerel, had been used. Clark and Almy (1918) give the fat content of a composite sample of weakfish, on May 1, as 2.34 per cent (fresh basis); on September 25 a similar composite sample contained 0.52 per cent. However, they observed also that different squeteague in the same school and various schools differ greatly in their fat content.

Fish in good condition and of as nearly uniform size as possible were obtained from wholesale fish dealers of Baltimore. After cutting the length of the belly, eviscerating, and removing the heads, they were salted with dry salt of known composition. The salt used was Baker's analyzed, chemically pure sodium chloride, or mixtures of this with other salts of the same grain size. This salt was just a little smaller grained than ground alum, or packer's salt, which is so widely used in the fish-salting industry. The salts were thoroughly mixed, so that all portions were of uniform composition. The fish were rolled in salt, and salt was sprinkled over each layer of fish, as is the practice of the trade. For every three parts, by weight, one part of salt was added when first salted.

After the fish had been in salt 24 hours one part, by weight, of salt was added for every 15 parts of fish. Later, at the end of six days, 1 part, by weight, of salt was added for every 30 parts of fish. The fish were placed belly down in 2-gallon stone jars. The above procedure was carried out in order to duplicate, if possible, the method of salting fish in use at Gloucester.

In the different experiments the temperature of salting was kept as near 68° F. as possible by surrounding the jars with running

water near this temperature. The temperature did not vary more than 2.7° from the average. The fish were sampled at about 48-hour intervals. In sampling, a transverse section, about 3 inches in width, was cut from a fish. A layer, 0.5 cm. in depth, was cut from the outside of the fish, which had been exposed to the brine. A second layer, underlying first layer 0.5 cm. thick, was then cut for a second sample. These samples were then dried at 100° C. and ground up. The percentage of chlorine was then determined by first carefully ashing the fish in silica dishes and afterwards titrating the chlorides with tenth-normal silver nitrate, using potassium chromate as indicator. The inner section (one-half to 1 cm. in depth) was found to be of the most uniform composition. Analysis of different fish from a single lot showed that this layer did not vary more than 1 per cent in chlorine.

DISCUSSION.

The results of the work which has been completed are given in Tables 1 to 4 and are shown graphically in the curves, figures 1 to 4. The work shown in Tables 2, 3, and 4 was all done at the same time with fish of the same relative freshness, and the temperatures of the brines were kept uniform. The work reported in Table 1 was done at a different time with a different lot of fish of somewhat larger size and heavier scale. As a result, the data in Table 1 are not comparable with those given in the other tables.

The results of the analyses of the dry fish samples are shown in Tables 1, 2, 3, and 4. The figures in all cases refer to the per cent of chlorine in dry fish. In Table 1 the analyses of sections of fish salted with a salt so prepared as to contain 1 per cent of calcium chloride and analyses of sections of similar squeteague salted with pure salt at the same time under identical conditions are presented.

TABLE 1.—RETARDATION OF PENETRATION OF SALT INTO FISH DUE TO 1 PER CENT OF CALCIUM CHLORIDE IMPURITY, EXPRESSED IN TERMS OF PER CENT OF CHLORINE IN DRY SAMPLE, AT 62.5° F.

Analysis of salt used.	Section of fish.	Per cent chlorine after—			
		1 day.	4 days.	7 days.	10 days.
Pure sodium chloride	Outer [a]	9.8	16.2	19.6	19.5
Do	Inner [b]	2.6	11.0	16.0	18.7
1 per cent calcium chloride, 99 per cent sodium chloride.	Outer [a]	8.7	10.8	15.2	16.6
Do	Inner [b]	2.5	7.9	14.1	14.4

[a] 0 to ½ cm. [b] ½ to 1 cm.

It is to be noted that the sections, both inner and outer, of the fish salted with pure salt ran higher in chlorine content than those salted with salt containing 1 per cent of calcium chloride.

In Table 2 data are presented which were obtained from the salting of another lot of squeteague with pure salt and from a similar lot salted with salt so prepared that it contained 1 per cent of magnesium chloride impurity.

TABLE 2.—RETARDATION OF PENETRATION OF SALT INTO FISH [a] DUE TO 1 PER CENT OF MAGNESIUM CHLORIDE IMPURITY, EXPRESSED IN PER CENT OF CHLORINE IN DRY SAMPLE, AT 68° F.

Analysis of salt used.	Per cent chlorine after—			
	1 day.	3 days.	6 days.	9 days.
Pure sodium chloride	9.8	16.0	19.7	22.4
1 per cent magnesium chloride, 99 per cent sodium chloride	6.5	15.7	18.7	19.0

[a] Inner section of fish, ½ to 1 cm.

In this case, also, the chlorine content of the inner sections of fish salted with pure salt is higher than that of similar sections of fish salted with the salt containing 1 per cent of magnesium chloride.

Table 3 shows that an increase in the amount of magnesium chloride to 4.7 per cent caused a further retardation.

TABLE 3.—RETARDATION OF PENETRATION OF SALT INTO FISH DUE TO 4.7 PER CENT OF MAGNESIUM CHLORIDE IMPURITY, EXPRESSED IN PER CENT OF CHLORINE IN DRY SAMPLE, AT 68° F.

Analysis of salt used.	Section of fish.	Per cent chlorine after—			
		1 day.	3 days.	6 days.	9 days.
Pure sodium chloride	Outer [a]	14.6	19.0	22.7	22.7
Do	Inner [b]	9.8	16.0	19.7	22.4
4.7 per cent magnesium chloride, 95.4 per cent sodium chloride.	Outer [a]	10.1	17.1	17.8	18.1
Do	Inner [b]	5.9	12.7	17.1	18.1

[a] 0 to ½ cm. [b] ½ to 1 cm.

Table 4 shows that the presence of the sulphate ion in solution caused a greater retardation than the consequent lowering of the concentration of the chlorine ion should cause.

TABLE 4.—RETARDATION OF PENETRATION OF SALT INTO FISH [a] DUE TO 10 PER CENT OF SODIUM SULPHATE IMPURITY, EXPRESSED IN PER CENT OF CHLORINE IN DRY SAMPLE, AT 68° F.

Analysis of salt used.	Per cent chlorine after—			
	1 day.	3 days.	6 days.	9 days.
Pure sodium chloride	9.8	16.0	19.7	22.4
10 per cent sodium sulphate, 90 per cent sodium chloride	7.1	10.5	15.3	17.1

[a] Inner section of fish, ½ to 1 cm.

Further than a retardation of the rate of penetration of the sodium chloride, calcium chloride and magnesium chloride had noticeable effects on the physical appearance of the salted fish. Both the calcium chloride and magnesium chloride as impurities in salt made a much harder fish than pure sodium chloride. Calcium chloride, apparently, was most active in this regard. Pure sodium chloride, when used dry for salting fish, produces a soft, yellow-meated fish which will bend when held in the hand. Five per cent of calcium

chloride as impurity is sufficient to produce a very stiff, hard fish. One per cent of calcium chloride produced a softer fish, but yet one which was much harder than that produced by pure sodium chloride. Four and seven-tenths per cent of magnesium chloride, as impurity, produced a fairly hard, stiff fish, with a very bright, shiny appearance.

Both calcium chloride and magnesium chloride, as impurities in salt, caused a very noticeable whitening. This whitening could easily

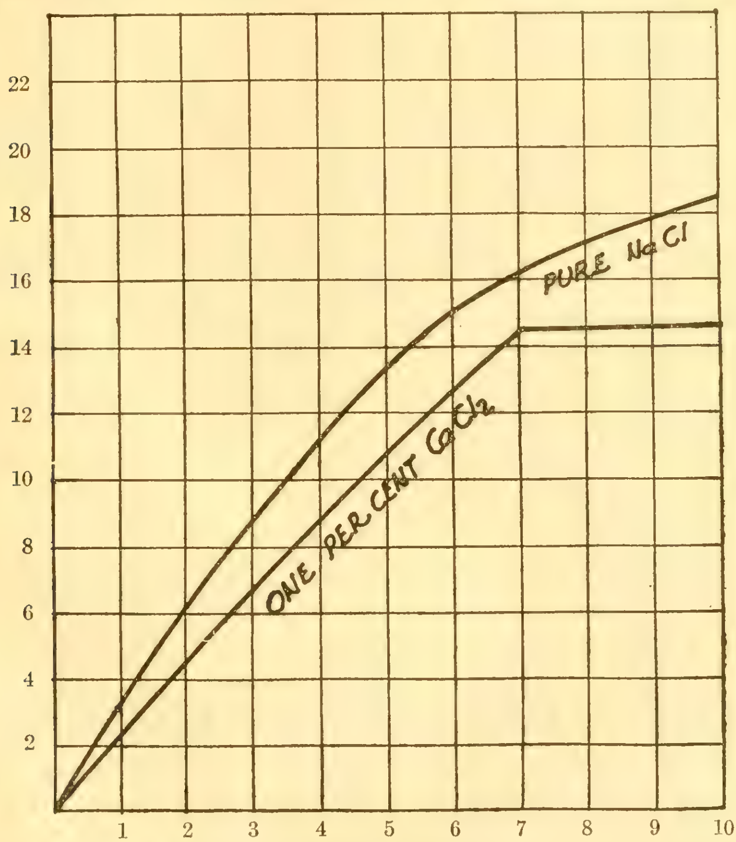

FIG. 1.—Curves show retardation of penetration of salt due to 1 per cent of calcium chloride impurity (section ½ to 1 cm. depth). Figures at left indicate per cent of chlorine in dry fish; at bottom, time in days.

be followed, as it was first observed in the outer portions of the fish and moved toward the center until at the end of from 10 to 13 days the fish was uniformly white throughout. Calcium chloride was most active in this regard.

Figures 1 to 4 illustrate graphically the data presented in the tables. In each case the time in days is plotted along the ordinate (horizontal line). The percentage of chlorine in the dry fish is plotted along the abscissa (vertical line).

Figure 1 shows how the percentage of chlorine in fish (the amount of sodium chloride contained in the fish) increases for 10 days. The

salts used were pure sodium chloride in one case and sodium chloride containing 1 per cent of calcium chloride in the other. It will be noted that after seven days the chlorine content of the fish salted with pure salt is nearly 2 per cent higher than that of the fish salted with salt containing 1 per cent of calcium chloride. The chlorine content of the fish salted with pure sodium chloride continues to increase rapidly, whereas the chlorine content of the squeteague salted

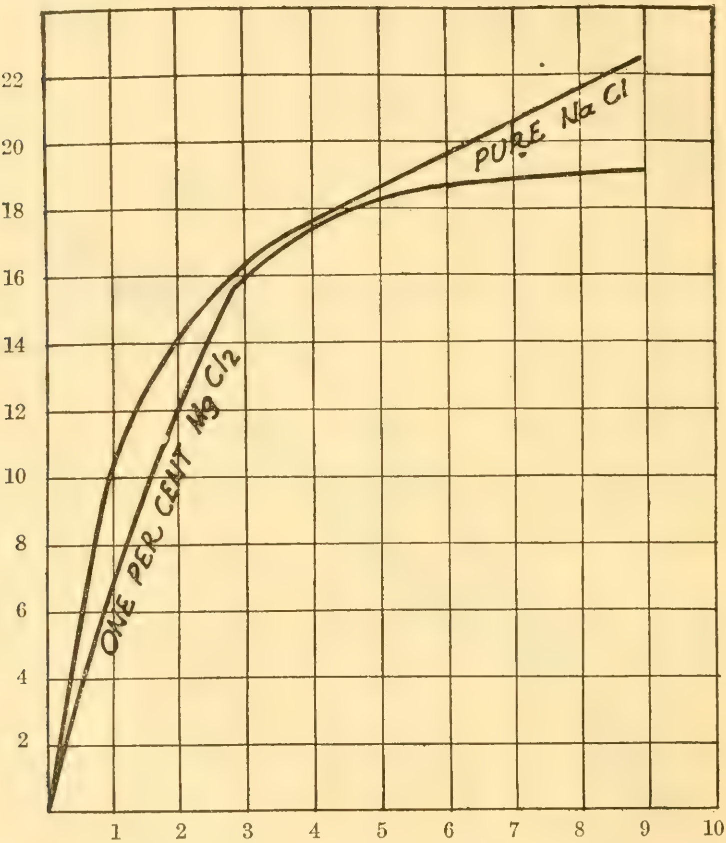

FIG. 2.—Curves show retardation of penetration of salt due to 1 per cent of magnesium chloride impurity (section ½ to 1 cm. depth). Figures at left indicate per cent of chlorine in dry fish; at bottom, time in days.

with salt containing calcium chloride increases very much more slowly.

Figures 2 and 3 show that the marked slowing up in the penetration of the salt into fish, due to the presence of magnesium chloride, begins in about six days after salting.

Figure 4 shows that the marked slowing up of the penetration of the salt into fish in the case of salt adulterated with 10 per cent of sodium sulphate occurs almost immediately. The amount of impurity used in this case was far in excess of any amount ever found in any commercial salt. It is doubtful whether small amounts of

sulphates found in commercial salts would have any appreciable effect on the penetration of salt in fish.

SUMMARY.

1. Small amounts of calcium chloride or magnesium chloride, as impurities in salt, retard the penetration of the sodium chloride into the squeteague.

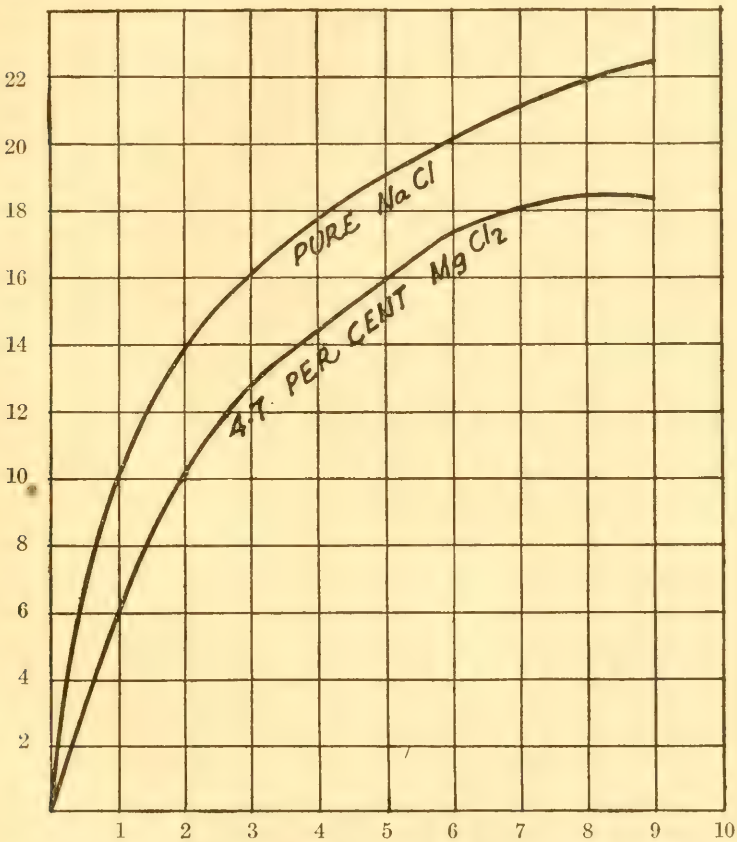

FIG. 3.—Curves show retardation of penetration of salt due to 4.7 per cent of magnesium chloride impurity (section one-half to 1 cm. depth). Figures at left indicate per cent of chlorine in dry fish; at bottom, time in days.

2. The sulphate ion has a similar, though less noticeable, effect.

3. Calcium chloride and magnesium chloride, as impurities in salt, cause a firmer, whiter fish than pure sodium chloride.

INFLUENCE OF IMPURITIES ON RATE OF PROTEIN DECOMPOSITION.[a]

INTRODUCTION.

When the consideration of obtaining the relative values of different methods of salting fish was first taken up, the rate of penetration of

[a] The analytical work reported in this section of the paper was done by J. F. Stephl, temporary assistant, U. S. Bureau of Fisheries.

chlorine into the fish was chosen as a criterion. The writer realized, however, that this alone was hardly a satisfactory criterion. Even if the salt penetrates fish with equal rapidity, it is no proof that the fish are keeping equally well. Different moisture contents would cause unequal keeping qualities; also, some impurities in the salt might have a greater preservative action than sodium chloride.

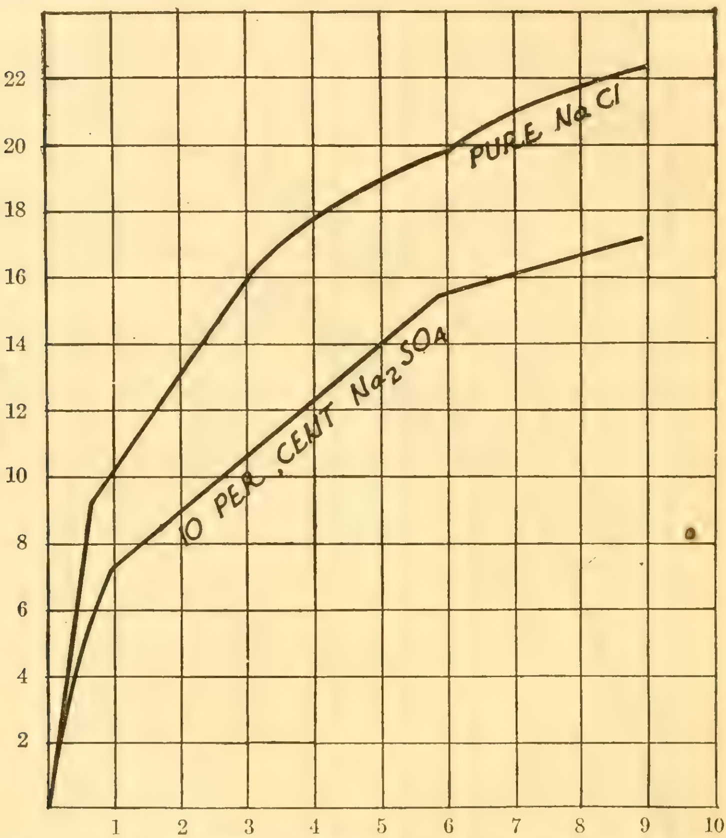

FIG. 4.—Curves show retardation of penetration of salt due to 10 per cent of sodium sulphate impurity (section one-half to 1 cm. depth). Figures at left indicate per cent of chlorine in dry fish; at bottom, time in days.

It was considered essential to have some means of measuring the amount and rate of decomposition of protein in order to judge as to how much decomposition took place while any given lot of fish was being salted. If the amount of decomposition at the end of the salting process were known, the real value of any salting method as a means of preserving fish would be known.

When proteins decompose, they break up, first, into simpler proteins, then into polypeptids, and then into amino acids. It is very difficult to measure accurately the amounts of simpler proteins and polypeptids in fish. However, the total amino-acid content of fish and brine is easily determined.

A number of experimenters have found that the amount of amino acid formed is an index of the total protein decomposition in meat and fish. Hoagland, McBryde, and Powick (1917), working on the decomposition of beef during cold storage, found that the amino-acid content of beef increased relatively more than any other constituent. They found that the amount of amino acid formed varied directly with the length of the storage period. They say:

The increases in amino nitrogen represent an accumulation of the end products of proteolysis and furnish an excellent index of the extent of protein autolysis. They are produced by the combined action of various proteolytic enzymes—protease and erepsin in particular—upon muscle proteins and their cleavage products. * * *

Amino nitrogen showed greater actual and relative changes than any other nitrogenous constituent. This result was to have been expected, since this constituent represents, in a large degree, an accumulation of the end products of proteolysis.

Bradley and Taylor (1917) used the estimation of amino acids by the formol-titration method to measure the rate of digestion of proteins.

Ottolenghi (1913) found that the amino-acid nitrogen content of meat was the best index of decomposition of meats. He used the amino-acid content to trace the ripening of meat to ascertain when active decomposition sets in. He found that only Sörensen's formol-titration method for determining amino-acid nitrogen and the microscopic examination for bacteria were of practical use for his purpose. Other methods were found to require too much time and elaborate manipulation.

METHODS.

Determination of amino-acid nitrogen.—It was necessary to use a method of estimating amino-acid nitrogen which did not require a complicated apparatus. The procedure had to be short, so that a large number of analyses could be made in a day. The formol-titration method is the only one that fulfills these requirements. Therefore, the amino-acid nitrogen was estimated in all cases by Sörensen's formol-titration method as modified by Benedict and Murlin.

The writer is well aware that this method is open to many objections. There are many slight errors due to the loss of diamino acids by precipitation, the high results given by some amino acids, and the low results given by others, etc. But for use as a measure of decomposition of protein a method does not need necessarily to give the exact amount of amino-acid nitrogen present in the fish or brine. If it gives results which are relative in all cases, it is sufficiently accurate for use where the results are used as an index of decomposition.

The procedure in the determination of amino-acid nitrogen in pickle was as follows: Twenty-five c. c. of brine were measured into a beaker. A quantity of 10 per cent phosphotungstic acid in 2 per cent hydrochloric acid, sufficient to precipitate all the protein, was added. This was allowed to stand overnight. The solution was then filtered and the precipitate washed. One c. c. of a 0.5 per cent solution of phenolphthalein was added and barium hydrate in substance until the solution turned a permanent red. After standing at least half an hour the solution was filtered and the precipitate washed. The solution was then neutralized with half-normal hydrochloric

acid. Enough tenth-normal sodium hydroxide was then added to turn the solution very slightly pink. Then 10 c. c. of neutral 40 per cent formalin were added and the solution titrated with tenth-normal sodium hydroxide. A blank on the formalin was run and this subtracted or added, as the case might be.

When the determination was made on the fish, the procedure was varied as follows: Sections were cut from four fish. These were cut into small pieces and mixed. Twenty-five grams of this mixture were weighed out and then ground in a mortar for 5 minutes. Twenty-five grams of salt were added, and the sample was washed out of the mortar. The sample was then made up to 250 c. c. volume and was allowed to stand on ice overnight; then sufficient was filtered off through a dry filter to obtain a 50 c. c. sample which was treated as in the case of the brine.

Before sampling the salt the residual salt was thoroughly mixed after draining off the brine. A 25-gram sample was then weighed out. After dissolving the salt in water sufficient phosphotungstic acid was added to precipitate the protein and ammonia present. From this point the procedure was the same as for the brine and fish. In every case, after precipitation with phosphotungstic acid, the supernatant liquid was tested to see if enough phosphotungstic acid had been added.

Salting of fish.—Great emphasis was placed on uniformity of procedure throughout this experimental work. The experiments concerning protein decomposition as affected by the impurities in salt were carried out on river herring caught in the Albemarle Sound. These fish were purchased from fishermen and were iced as soon as they were brought ashore. This was about 1½ hours after capture. They were then immediately cleaned thoroughly. The following procedure was followed in salting lots numbered FA–1, FA–4, FA–5, and FA–6. These results are reported in Table 5, page 32.

The heads and all viscera were removed and the fish split along the belly to the vent. They were then soaked in ice water for an hour. The under side of the backbone was scraped free from blood, and all blood was washed out. The fish were then drained free from water, weighed, and salted. The river herring were rolled in salt and packed tightly, belly up, in layers in kits. Some salt was sprinkled over each layer of fish. No brine was added; the fish developed their own pickle. When packed, a weight of salt equal to one-third the weight of the fish was added. The following day a weight of salt equal to one-twelfth the weight of the fish was added.

The salt used was either the commercial brand of salt known as Diamond Flake, or mixtures of this salt with chemically pure salts of similar degrees of fineness. Diamond Flake salt is a fine-grained salt prepared in Michigan, the analysis of which is given on page 18.

Previously, an experiment had been run to determine whether the impurities present in commercial Diamond Flake salt were of sufficient importance to cause a variation in its preservative action on fish from that of chemically pure sodium chloride taken as a standard. The result of this work showed that the differences in the amounts of amino-acid nitrogen formed in these two cases was within the limit of the experimental error.

The kits of salted fish were immediately placed in a large, constant-temperature vat capable of holding seven small kits. The kits were held at a definite constant temperature throughout the salting period. In this case the temperature of lots FA–1, FA–4, FA–5, and FA–6 was held at 79° F.

These large, constant-temperature vats were steel tanks. They were about half filled with water, which was electrically heated. A framework was built around them, and the space between the framework and the vats was filled with sawdust. They were fitted with wood covers and were also covered with paper and oilcloth. This effectually thermally insulated them. Hasselbring thermoregulators operated a relay system which regulated the operation of the heaters. A water motor drove the stirrers, which efficiently kept the vats at a uniform temperature throughout. In this experiment the temperature did not vary more than 1° F. from the average.

Analysis of fish.—Samples of the fresh fish were analyzed at the beginning of the experiment. It was found that uniformly cleaned, fresh alewives have practically the same amino-acid content. In the case of the well-cleaned and well-washed alewives this is about 0.02 per cent amino-acid nitrogen (fresh basis). This fact might be utilized in judging freshness of fish.

At the end of the experiment the fish, brine, and salt were weighed and sampled. The samples were analyzed for amino-acid nitrogen, according to the method described. The total weights of amino-acid nitrogen in the brine, residual salt, and fish were calculated. These were added together, and the total weight of amino-acid nitrogen contained in the fresh fish subtracted from their sum. This gave the total weight of amino-acid nitrogen formed. This figure was divided by the original weight of the fish in kilograms. The result is the weight of the amino-acid nitrogen formed per kilogram of fish.

This work is based on the supposition that the greater the decomposition of protein the greater will be the amount of amino-acid nitrogen formed, inasmuch as the chief product of autolysis is amino-acid nitrogen. Where decomposition takes place so rapidly that the chief action is bacterial, amino-acid nitrogen is also formed; but in this case it is merely an intermediate product as the end products of bacterial action are ammonia and nitrogen. In such cases ammoniacal nitrogen ought also to be determined. The experimenter was always limited by lack of time and facilities for elaborate chemical work. This is inevitable unless the investigator has the use of a complete chemical laboratory close to a large continuous supply of fresh fish and has the help of a corps of assistants.

As long as there was but little spoilage of fish in the experiment, the results of the amino-acid determinations from different lots salted under identical conditions checked excellently. But when the spoilage was great enough to cause the formation of foul-smelling gases and was quite evidently of a bacterial nature the amounts of amino-acid formed did not show what was anticipated. Surely, in such cases the ammoniacal nitrogen ought to have been determined.

The results of the analyses and calculations are given in Table 5.

TABLE 5.—EFFECT OF CALCIUM CHLORIDE AND MAGNESIUM CHLORIDE IN SALT ON RATE OF AMINO-ACID FORMATION IN SALTED FISH.[a]

[Lots D refer to samples dry-salted, and lots S to those brine-salted.]

Lot No.	Method of cleaning.	Analysis of salt.	Weight of salt and brine used.	Salting period. Average temperature.	Salting period. Length.	Weight of fresh fish.	Amino-acid nitrogen in fresh fish.	
		Per cent.	*Kgs.*	*°F.*	*Days.*	*Grams.*	*Per ct.*	*Grams.*
FA-1:D	Heads removed; eviscerated; well washed.	5.0 calcium chloride; 0.37 calcium sulphate; 94.78 sodium chloride.	c1.66	79	7	4,000	0.02	0.80
FA-4:D	do	5.0 magnesium chloride; 0.37 calcium sulphate; 94.78 sodium chloride	c1.25	79	7	3,000	.02	.60
FA-5:D	do	99.78 sodium chloride, Diamond Flake.	c1.25	79	7	3,000	.02	.60
FA-6:D	do	do	c1.25	79	7	3,000	.02	.60
DA-8:S	Heads removed; eviscerated with exception of milt and roe.	do	b6, c1	75	9	5,000	.022	1.10
DA-9:S	do	94.78 sodium chloride; 5.0 sodium sulphate; 0.37 calcium sulphate.	b6, c1	75	9	5,000	.022	1.10

Lot No.	Total amino-acid nitrogen at end in— Fish.	Brine.	Salt.	Fish, brine, and salt.	Amino-acid nitrogen formed. Total.	Per kilogram fresh fish.	Physical condition of salted fish.
	Grams.	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*	
FA-1:D	2.20	0.53	0.07	2.80	2.00	0.500	Good; hard; whitened.
FA-4:D	1.17	.52	.05	1.74	1.14	.380	Do.
FA-5:D	1.00	.50	.07	1.57	.97	.323	Good; hard; yellow-white.
FA-6:D	1.07	.48	.06	1.61	1.01	.336	Do.
DA-8:S	2.46	2.09	None.	4.55	3.45	.69	Contained 2 bad fish; total number, 25.
DA-9:S	2.82	1.97	None.	4.79	3.69	.74	Contained 3 bad fish; total number, 25.

[a] The fish in this experiment were salted four hours after capture. [b] Brine. [c] Salt.

DISCUSSION.

Effect of calcium and magnesium salts.—It should be noted that the amounts of impurities, calcium, magnesium, and sodium sulphate that were added are great. The combined amounts of calcium and magnesium salts occurring in commercial salts is seldom over 4 per cent. The analyses given on pages 18 and 19 show the composition of various commercial salts.

More amino-acid nitrogen was formed in lot FA-1 than in lots FA-4, FA-5, or FA-6. Lots DA-8 and DA-9 were cleaned in a different manner and were salted in brine instead of dry salt; so these results are not comparable with the results of the lots numbered FA.

Lot FA–1 was salted with salt containing calcium chloride as impurity. This increase in the amount of amino-acid nitrogen formed was about 50 per cent over the weight of amino-acid nitrogen formed when pure salt was used. In other words, there was a half more decomposition of the protein when the salt contained 5 per cent of the calcium chloride than when no calcium chloride was present. Five per cent of calcium chloride is only the equivalent of 1.8 per cent of calcium. This is a greater amount than was contained in any whose analyses are given in the tables of salt analyses.

Salt sample number MD 16102 contained 1.33 per cent calcium. However, it will be noted that the total impurity amounted to 7.3 per cent. Lot FA–4 was salted with salt containing 5 per cent of magnesium chloride. In this case 0.380 gram of amino-acid nitrogen was formed during the salting period. This is 15 per cent more than when pure salt was used (FA–5, FA–6). However, 5 per cent of magnesium chloride is 1.28 per cent of magnesium, which is double the amount of magnesium likely to be found in any commercial salt.

If the salt analyses given previously are consulted, it will be seen that the Trapani salt sample is the only one that contains a very large amount of magnesium and that this amount is less than 3 per cent of total magnesium salts. It seems unlikely, therefore, that the amounts of magnesium salts contained in commercial salts have any appreciable deleterious effect on the fish-curing properties of any salt.

Effect of sodium sulphate.—Samples DA–8 and DA–9 were prepared for salting by cutting off the heads and cutting the length of the abdominal cavity. All viscera were removed with the exception of the milt or roe. As the milt and roe were left in the fish, it was impossible to wash the fish thoroughly, or to remove all the blood. For this reason the maximum temperature of salting was greatly lowered, even though all other conditions were identical. These fish were salted in brine. For every gram of fish taken 1 c. c. of brine was used. At the time of salting a considerable excess of solid salt was added. From time to time more solid salt was added. The fish were stirred daily. Sufficient salt was added to keep the pickle saturated at all times. The amount of salt required for this purpose was about one-fifth of a gram of salt for every gram of fish.

The samples were taken at the end of the salting period. They were analyzed, and the calculations were made in the manner previously described. Lot DA–8 was salted with nearly pure salt. The salt used in lot DA–9 contained 5 per cent sodium sulphate as impurity. These lots were salted just above the maximum temperature for fish cleaned in this way (containing roe, milt, and blood). Any differences in the preserving or penetrating powers of the salts used should show up very noticeably under these conditions. Yet there is only a difference of 7 per cent in the amount of amino-acid nitrogen formed. There is a little more decomposition in the case of the salt containing the sodium sulphate, but the difference is slight. There is usually not more than 2 per cent of sulphates contained in commercial salts. Had the amount of sodium sulphate been reduced to 2 per cent it is likely that the difference between the preservative power of the impure salt and the pure salt would have hardly been noticeable.

These results concerning the rate of formation of amino-acid nitrogen check with those on the penetration of chlorides; that is, where there was a slowing up in the rate of penetration of chlorides, there is an increase in the rate of amino-acid formation. The changes are approximately the same, except in the case of the effect of the sulphates. The results obtained from the work on rate of penetration of salt adulterated with sodium sulphate show a marked decrease in the rate of penetration, due to the impurity. The increase in rate of production of amino acids due to the presence of this impurity is very slight. However, the work on the rate of penetration was done with salts containing 10 per cent of sodium sulphate. It may be that this marked retardation takes place only at high concentrations of sodium sulphate, when there is a marked hardening of the tissues.

DISCUSSION.

PHYSICAL EFFECTS ON FISH.

This work on the preservative action of different salts was done on alewives, whereas the penetration of salts were followed in squeteagues. The hardening and whitening action of calcium and magnesium salts was marked on alewives; but it was less noticeable than in the case of squeteagues. Five per cent of sodium sulphate had practically no whitening action on alewives and very little hardening action. It may be that 10 per cent of sodium sulphate in salt is required to bring out the whitening power. No lot of alewives was salted with salt containing more than 5 per cent of sodium sulphate.

A POSSIBLE EXPLANATION OF RESULTS.

The writer believes that the hardening action of calcium and magnesium salts on the tissues of the fish is responsible for the retardation of the penetration of the chlorides. This, in turn, is at least partially responsible for the lesser preservative action of the impure salts. Sodium sulphate evidently acts only when in greater concentrations than it is ordinarily found in commercial salts. Its deleterious action as an impurity is, therefore, not to be feared.

PRACTICAL APPLICATION.

When fish are salted at any temperature averaging below 50° F., salts may be chosen that will produce the desired quality of salted fish. When a hard, white fish is desired, salts high in calcium and magnesium salts may wisely be chosen. However, if a soft, pliable fish is desired, pure salts should be used.

When the average temperature of salting is above 50° F., greater care should be used in the selection of salt. This becomes of particular importance when the fish are salted, either round or containing blood, roe, or milt, as these fish are much more likely to spoil than when they are thoroughly cleaned. In this case the smaller the amounts of calcium and magnesium salts present the more desirable the salt. Fish salters working in warm climates should strive to obtain salt containing less than 1 per cent of total calcium and magnesium salts. Sulphates are never present in large enough quantities to lower the effectiveness of the salt as a preservative.

EFFECT OF FINENESS OF SALT.

The writer considered the fineness of salt as of little importance, save in a physical way. Inasmuch as his time was limited, he conducted no experiments to determine the optimum degree of fineness of salt for use in fish salting. This factor is entirely eliminated when fish are salted by the brine method. When small fish are salted with dry salt, care must be taken not to use too coarse a salt, such as Turks Island. When such a coarse salt is used, great difficulty will be encountered in obtaining a uniform distribution of the salt throughout the barrel or butt of fish. Nearly all of the salt used will be on the outside of the fish. If, however, fine salt be used, a considerable portion of the salt will be inside the abdominal cavity. This abdominal cavity usually is quite moist; so almost immediately a strong pickle will be formed which will begin to penetrate the fish. Fine salt certainly has the advantage of being easier to distribute evenly throughout a container of fish regardless of the size of the fish. However, in the case of cod and other large fish fine salt gives the fish a somewhat different appearance. In such cases, when the weather is cold, appearance should be the first consideration. If such large fish are salted in warm, southern climates, less consideration can be given to the appearance of the product. In such climates the first considerations must be the composition of the salt and its uniform distribution throughout the container of fish.

SUMMARY.

Calcium and magnesium salts and various sulphates cause a retardation of the penetration of salt into fish. These salts also cause a less perfect preservation of the fish during salting. This was shown by increased amounts of amino acids formed during the salting period. Calcium is most powerful in this regard. Magnesium salts cause a considerable increase in the rate of decomposition during salting, other conditions being the same. But this effect is not nearly so great as that caused by calcium salts. Sulphates do not cause an appreciable increase in the rate of decomposition at the concentrations at which they are present in salt. The fish salter working under adverse conditions in warm climates should use care in the selection of his salts and choose salts that are low in calcium and magnesium.

II. A COMPARISON OF EFFICIENCY OF BRINE AND DRY SALT FOR SALTING FISH.

INTRODUCTION.

At present fish are salted either by the use of dry salt or brine and salt. Before improvements in either method could be suggested it was considered essential to know the relative merits of the two methods at various temperatures. The work presented in this section of this paper was undertaken, therefore, with that aim in view.

The dry-salt method involves the packing of fish with salt in a water-tight container. The water and body juices of the fish dissolves sufficient salt to make enough "pickle" to cover the fish. A small pile of salt is usually placed on top of the container to press

down the fish and keep them covered. The fish are not disturbed until the end of the salting period.

In the brine method of salting fish the procedure is as follows: Fish are dumped into a vat containing enough brine nearly to cover them, and a considerable quantity of salt is added along with the fish. Each day more salt is added, and the fish are stirred in the "pickle." The purpose of adding the salt is to maintain the brine as near saturation as possible.

In these experiments these two methods were given a trial. The commercial methods were imitated as closely as possible in order to fairly compare the methods.

DETERMINATION OF RATES OF PROTEIN DECOMPOSITION.

METHOD.

Ninety pounds of reasonably fresh squeteague (*Cynoscion regalis*) were obtained. The fish had been caught two days previously and had been kept on ice. There were 120 fish in all, making the average weight three-fourths of a pound. They were cut down the belly and eviscerated. The tails and heads were cut off, and the fish were washed in ice water.

After cleaning there remained 23.4 kg. of fish. These were divided into 12 lots. Six lots of 1.3 kg. each and six other lots containing 2.6 kg. each were weighed out. To each of the smaller lots were added 1,300 c. c. of saturated sodium chloride solution and 250 grams of pure, dry sodium chloride. The fish of the larger lots were rubbed in chemically pure dry salt and then packed in glass dishes, cut surface down, and sodium chloride was sprinkled over each layer. The 2.6 keg of fish just made two layers; 990 grams of salt were used in this way on each lot. The salt used in this experiment was chemically pure "Baker's analyzed" sodium chloride. This salt is a little smaller grained than "ground alum."

One of each of the lots of fish was then placed in a different constant-temperature compartment. The fish were permitted to remain in this constant-temperature apparatus for nine days. The brine-salted lots of fish were stirred daily. The temperature in any one compartment did not vary more than 1° F. from the average. The brines were sampled and analyzed for amino-acid nitrogen on the first, third, fifth, seventh, and ninth days. At the end of the experiment the fish and salt were also analyzed for amino-acid nitrogen. In the case of fish to which the brine had been added not more than 25 grams of salt remained undissolved. The amount of amino-acid nitrogen in this small amount of salt was considered negligible. In all cases, however, there was an excess of undissolved salt at the end of the salting period.

The method of sampling the fish, brine, and salt was described in the first section of this paper. The method of analysis of the samples for amino-acid nitrogen was the formol-titration method, which was described on page 29.

DISCUSSION.

Table 6 shows the titration values obtained by the formol titration for amino acids of 25 c. c. of the brines. These figures are given

to show the rate at which the amino acid diffuses out into the brine. They also point out a means of forecasting spoilage of fish.

TABLE 6.—INCREASE IN AMINO-ACID CONTENT OF BRINES.

[Figures refer to c. c. N/10 NaOH amino acid contained in 25 c. c. of brine: Lots D refer to samples dry salted; lots S, to those brine salted.]

Lot.	Brine collected after—					Temperature.
	19 hours.	67 hours.	5 days.	7 days.	9 days.	
	C. c.	*C. c.*	*C. c.*	*C. c.*	*C. c.*	°*F.*
2 D	4.7	5.0	5.1	5.1	6.5	63
2 S	1.3	2.0	2.1	2.7	3.4	63
3 D	4.7	4.9	5.6	5.4	7.1	70
3 S	1.4	2.4	2.3	2.7	4.2	70
4 D	4.4	5.2	5.7	5.9	7.6	75.5
4 S	1.4	2.6	2.5	3.2	4.4	75.5
5 D	4.4	5.1	7.0	7.6	8.5	80
5 S	1.2	2.7	3.0	4.2	*a* 5.3	80
6 D	4.1	4.8	8.7	*a* 9.6	*a* 10.1	87
6 S	1.3	3.4	3.7	*a* 5.2	*a* 7.2	87
7 D	4.4	7.2	*a* 10.3	*a* 13.0	*a* 16.0	93
7 S	1.1	3.4	*a* 4.6	*a* 6.6	*a* 9.5	93

a Spoilage of fish noted.

Apparently the water contained in the fish diffuses out more rapidly in the case of the dry-salted fish. Above 86° F. sufficient brine to cover the fish was formed from the dry salt in 15 hours. About 30 hours were required for the lots at 70 and 63° F. to form enough brine to cover all the fish. The lots at 75.5 and 80° F. formed sufficient brine to cover the fish in somewhat less time. The gradual increase in the amino-acid content of the brines of the brine-salted fish (S) was probably due to the slow diffusion out of the water containing the amino acids dissolved in it. The immediate rise of the amino-acid titration value to about 4.5 c. c. in the dry-salt method was probably due to the rapid movement outward of the water in the fish.

When the amino-acid titration values rose above 9 c. c. in the dry-salted lots, the fish (D) were found to be spoiled. This was observed in five days at 93° F. and in seven days at 87° F. The lot at 80° F. did not spoil in this case.

In the case of those fish salted in brine (S) when the formol-titration value rose to 5 c. c. N/10 alkali, the fish were observed to be spoiled. This was noted at five days for those at 93° F.; at seven days for those at 87° F.; and at nine days for those at 80° F.

TABLE 7.—VOLUMES OF BRINE FORMED DURING SALTING.

[Lots D refer to samples dry salted; lots S, to those brine salted.]

Lot.	Weight of fish.	Volume.	Lot.	Weight of fish.	Volume.
	Kg.	*C. c.*		*Kg.*	*C. c.*
2D	2.6	770	5D	2.6	780
2S	1.3	1,580	5S	1.3	1,625
3D	2.6	815	6D	2.6	850
3S	1.3	1,610	6S	1.3	1,670
4D	2.6	820	7D	2.6	680
4S	1.3	1,670	7S	1.3	1,620

The figures in Table 6, together with the volumes of the brine given in Table 7, were used to calculate the total amounts of amino-acid nitrogen formed in the brines. These figures are given in Table 8.

TABLE 8.—TOTAL AMOUNT OF AMINO-ACID NITROGEN FORMED IN BRINES.

[Lots D refer to samples dry salted; lots S, to those brine salted.]

Lot.	Total amount amino nitrogen after—					Temperature.
	19 hours.	67 hours.	5 days.	7 days.	9 days.	
	Grams.	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*°F.*
2 D	0.203	0.215	0.220	0.220	0.311	63
2 S	.115	.168	.176	.238	.304	63
3 D	.217	.224	.254	.250	.328	70
3 S	.130	.215	.205	.247	.380	70
4 D	.201	.238	.259	.270	.349	75.5
4 S	.133	.242	.233	.298	.412	75.5
5 D	.192	.222	.310	.367	.412	80
5 S	.112	.246	.273	.392	.498	80
6 D	.197	.230	.414	.505	.532	87
6 S	.126	.317	.345	.488	.677	87
7 D	.168	.273	.392	.499	.614	93
7 S	.104	.310	.417	.602	.867	93

In order to make the figures in Table 8 comparable, the total amounts of amino-acid nitrogen formed were divided by the weights of fish salted in the different lots. These figures are presented in Table 9.

TABLE 9.—AMOUNT OF AMINO-ACID NITROGEN FORMED IN BRINE PER KILOGRAM OF FISH.

[Lots D refer to samples dry salted; lots S, to those brine salted.]

Lot.	Amino-acid nitrogen per kilogram of fish after—					Temperature.
	19 hours.	67 hours.	5 days.	7 days.	9 days.	
	Grams.	*Grams.*	*Grams.*	*Grams.*	*Grams.*	°F.
2 D	0.078	0.083	0.085	0.085	0.119	63
2 S	.089	.129	.135	.183	.234	63
3 D	.084	.086	.098	.097	.126	70
3 S	.100	.165	.158	.190	.292	70
4 D	.077	.092	.099	.104	.134	75.5
4 S	.102	.186	.179	.228	.316	75.5
5 D	.074	.086	.119	.141	.158	80
5 S	.086	.189	.210	.300	.383	80
6 D	.076	.089	.159	.195	.208	87
6 S	.097	.244	.266	.377	.510	87
7 D	.065	.105	.151	.193	.236	93
7 S	.080	.238	.320	.465	.666	93

At the end of the experiment samples from each lot were cooked. All the fish salted at 87 and 93° F. were spoiled. About 20 per cent of the fish salted in brine at 80° F. were spoiled. None of the fish salted by the dry-salt method at this temperature (80° F.) were spoiled. Fish salted with dry salt at 80° F. were eaten both by Prof. B. P. Livingston and the writer and were pronounced satisfactory. All fish salted at lower temperatures were in good condition. The results of the cooking trials check with the amount of decomposition, as shown by the total amount of amino acids formed in Table 10.

A composite sample of the fresh squeteague gave on analysis 0.022 per cent amino-acid nitrogen. This figure was found to be fairly constant for squeteagues but was higher when the samples had been iced for a long period.

In Table 10 the various amounts of amino-acid nitrogen formed in the brine, fish, and salt are given; also the total amino-acid nitrogen formed and the total amount of amino-acid nitrogen formed per kilogram of fish is given.

TABLE 10.—TOTAL AMOUNT OF AMINO-ACID NITROGEN FORMED DURING SALTING PERIOD.[a]

[Lots D refer to samples dry salted; lots S, to those brine salted.]

Lot.	Amount of salt used.	Amount of brine used.	Average temperature of salting period.	Weight of fresh fish.	Amino-acid nitrogen in fresh fish.	
	Grams.	C. c.	° F.	Grams.	Per cent.	Grams.
2 D	990	....	63	2,600	0.022	0.572
2 S	250	1,300	63	1,300	.022	.286
3 D	990	....	70	2,600	.022	.572
3 S	250	1,300	70	1,300	.022	.286
4 D	990	....	75.5	2,600	.022	.572
4 S	250	1,300	75.5	1,300	.022	.286
5 D	990	....	80	2,600	.022	.572
5 S	250	1,300	80	1,300	.022	.286
6 D	990	....	87	2,600	.022	.512
6 S	250	1,300	87	1,300	.022	.286
7 D	990	....	93	2,600	.022	.572
7 S	250	1,300	93	1,300	.022	.286

Lot.	Total amino-acid nitrogen at end in— Fish.	Brine.	Salt.	Fish, brine, and salt.	Amino-acid nitrogen formed. Total.	Per kilogram fresh fish.	Increase over dry-salt method.	Physical condition of salted fish.
	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Per cent.	
2 D	0.660	0.311	0.056	1.027	0.455	0.175	....	Good.
2 S	.333	.304	.000	.637	.351	.270	54	Do.
3 D	.675	.328	.065	1.068	.496	.190	....	Do.
3 S	.285	.380	.000	.665	.379	.292	54	Do.
4 D	.783	.349	.053	1.185	.613	.236	....	Fair.
4 S	.332	.412	.000	.744	.458	.352	49	Do.
5 D	[b].934	.412	.078	1.424	.854	.328	....	Do.
5 S	[b].451	.498	.000	.949	.663	.510	55	Spoiled.
6 D	[b]1.276	.532	.068	1.896	1.324	.510	....	Do.
6 S	[b].594	.677	.000	1.271	.985	.756	48	Do.
7 D	[b]1.492	.614	.096	2.202	1.630	.628	....	Do.
7 S	[b] .610	.867	.000	1.477	1.191	.916	45	Do.

[a] In this experiment the fish were cleaned after two days' icing by removing the heads, eviscerating, and washing carefully, and were salted for nine days.

[b] Number is slightly high because of the accidental discard of the sample by one of the writer's coworkers. The result given is from sample taken three days after the fish had been removed from the constant-temperature compartments. The fish were kept at 64.5° F. during those three days. However, any slight error would be the same for all samples.

These figures show that the total amounts of amino-acid nitrogen formed are much greater in the case of the brine-salted fish. The increase varies from 48 to 55 per cent. This seems to prove that

the brine-salt method is not as efficient in preserving fish as the dry-salt method.

The writer wishes to point out the value of the amino-acid content of fish and brine as a criterion in estimating and detecting spoilage. Any two lots of the same fish may be compared and their relative freshness determined. This may be used for either fresh or salted fish. If the fish have been salted by the same process, this may be done quite easily by determining amino-acid nitrogen in the brines.

It also seems probable that the increase in amino-acid content could be used to forecast spoilage of fish during the salting period. A rapid rise in the amino-acid content of the brine would warn the salter that his fish were in danger of spoiling, and the salter could remove them to cold storage or use stronger brine.

RATE OF PENETRATION OF SALT.

In addition to following the formation of amino-acid nitrogen in fish salted by these two ways, the rate of penetration of chlorides into squeteagues was followed. This was accomplished in the same manner as the determination of the rates of penetration of different salts described on page 22.

METHOD.

The general procedure in these experiments was as follows: Fish of a uniform size (3.5 cm. thickness) were salted with pure sodium chloride by the two methods described on page 36. These two jars of fish were placed in a constant-temperature compartment and sampled at the end of 1, 4, 7, and 10 days. The temperature of the fish did not vary more than 1.44° from the average of 69.44° F. The samples were dried and ashed and the chlorine determined by titration with a silver-nitrate solution. The results are given in Table 11.

Table 11.—Penetration of Salt into Squeteague, Expressed in Terms of per cent of Chlorine in Dry Sample, at 70° F.

Method of salting.	Section of fish.	Per cent chlorine after—			
		1 day.	4 days.	7 days.	10 days.
Dry salted	Outer [a]	9.8	16.2	19.6	19.5
Do	Inner [b]	2.6	11.0	16.0	18.7
Brine salted	Outer [a]	8.4	15.3	17.3	17.8
Do	Inner [b]	1.8	8.3	12.2	15.7

[a] 0 to ½ cm. [b] ½ to 1 cm.

DISCUSSION.

The percentage of salt in both sections is higher throughout in the case of the dry-salted fish than in the brine-salted fish. This shows that the salt penetrated more rapidly in the case of the dry-salt method. More data could be given which verify the results of this experiment.

This work agrees with the results obtained by the estimation of the rate of amino-acid formation. For, when the salt penetrates

more rapidly, as in the case of the dry-salt method, less amino acids are formed than when the salt penetrates more slowly. However, the retardation of the rate of penetration is less marked. This suggests the possibility that small differences in salt content of fish may be responsible for much greater differences in the rate of decomposition of the fish.

Figure 5 illustrates graphically the data given in Table 11. It should be noted that the difference in chlorine content gradually increases.

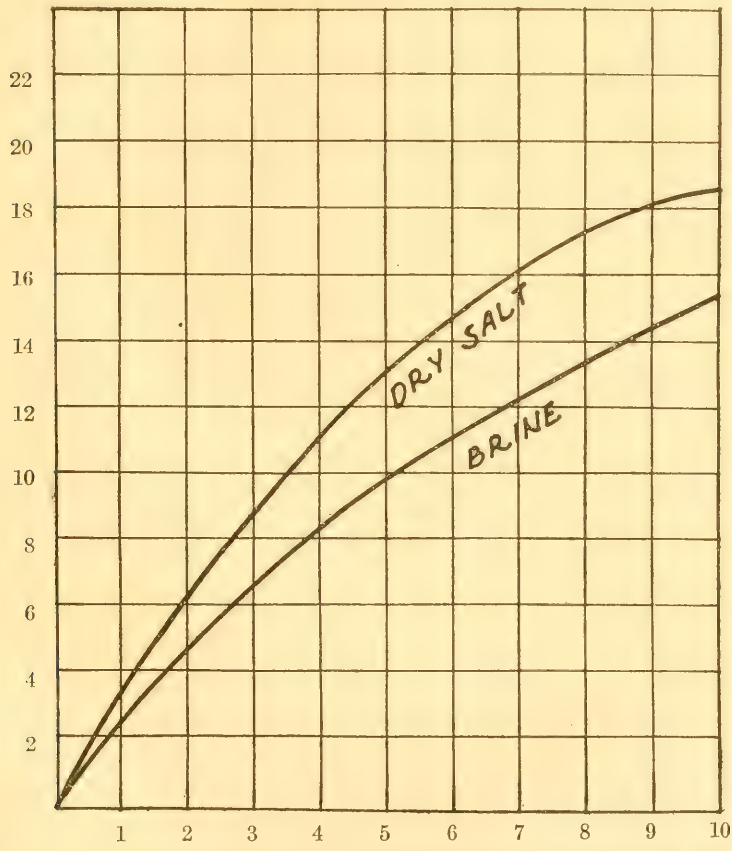

FIG. 5.—Curves show comparative rates of penetration of salt into fish when dry salted and when brine salted (section one-half to 1 cm. depth). Figures at left indicate per cent of chlorine in dry fish; at bottom, time in days.

DISCUSSION.

PHYSICAL DIFFERENCES BETWEEN THE PRODUCTS OF THE TWO METHODS.

Dry-salted fish are invariably harder than brine-salted fish. This is probably due to the difference in moisture content. Brine-salted fish are about 7 per cent higher in moisture than dry-salted fish at the end of a salting period of 10 days. Dealers who "tight pack" their fish state that dry-salted fish require very little draining, whereas the brine-salted fish must be drained and dried for at least four days.

Dry-salted fish have a shriveled appearance, due to their drier condition. They are also brighter in appearance, as a less number of scales have been knocked off.

HYPOTHESIS TO ACCOUNT FOR RESULTS.

There are three important means of preserving foodstuffs, namely: 1. By destruction of bacteria and enzymes, which is accomplished by sterilization with heat. 2. By desiccation, or removal of water; bacteria do not thrive, nor are enzymes active in the absence of water. 3. By the addition of a preservative, which inhibits the growth of bacteria and the action of enzymes.

When fish are preserved by salting, we make use of the two last-mentioned means of preservation. The salt not only penetrates the fish but also dissolves and removes water. In some way dry salt removed more water from fish than brine. In the case of the dry-salt method the salt content of the fish is greater. The lesser decomposition taking place during dry salting than during brine salting is evidently due to these two facts.

It is not clearly understood just why the salt penetrates more rapidly when the dry-salt method is used. After stirring a vat of fish which are being brine-salted, the concentration of the upper layers of pickle immediately begins to decrease. It decreases most rapidly just after the fish are put in. In large vats of fish, the pickle sometimes becomes as weak as 60° (60 per cent saturation), even though there may be solid salt in the vat. Of course, this diluted brine is not so active as saturated brine. Also, it may happen that, although the pickle appears saturated according to the hydrometer reading, that in contact with the fish is not saturated, for water continually comes out of the fish and dilutes the brine in the vicinity of the fish. It would be well to try an experiment comparing the brine-salting method with the dry-salt method and have both brines stirred continually. The writer believes that both methods would show up equally well in such a test.

DRY-SALT METHOD MORE ECONOMICAL.

The dry-salt method involves a little more work at the beginning of the salting period; for more labor is involved in thoroughly distributing the salt throughout a large quantity of fish than is required to make up a brine and put the fish and salt into it. But after packing the fish into butts with dry salt, no further labor is required; whereas, brine-salted fish must be "roused" (stirred up), and salt must be added every day during the salting period. "Rousing" is an operation that requires considerable time and labor, and since the fish must be roused eight or nine times, the total labor expended in this process is large. There is no reason, therefore, for the brining of fish in order to save labor, as in the long run this process is not economical in respect to labor.

At present the used pickle from both processes is thrown away. It is the custom to save the surplus salt used in the dry-salt method. A great deal more pickle is left at the end in the brine method. This involves a greater loss of salt, when it is discarded, than when the smaller amount of dry-salt pickle is thrown away. The dry-salt

method is, therefore, more economical in regard to salt, as well as to labor.

SUMMARY.

1. The formation of amino-acid nitrogen was followed in the brine during the salting of fish by two methods—salting by use of dry salts and salting by use of brine.

2. The total amount of amino-acid nitrogen formed during salting was calculated.

3. More amino acid was formed by the brine method of salting.

4. The estimation of the amino-acid nitrogen content of fish and brine was suggested as a means of detecting and also forecasting spoilage.

5. The rate of penetration of salt into the squeteague when salted with dry salt and when salted with brine was determined. Salt applied dry goes into the fish more rapidly.

6. Samples of the fish salted by the two methods under consideration were cooked. It was found that all of the fish salted with dry salt at 80° F. were edible. Those salted with brine were unfit for consumption.

7. The dry-salt method was found to be more economical both of labor and salt.

These results show that the dry-salt method of salting fish, as practiced commercially, is much more efficient in preserving fish than the brine method. The dry-salt method is also the more economical of the two.

III. INFLUENCE OF METHOD OF CLEANING FISH FOR SALTING.

INTRODUCTION.

IMPORTANCE OF METHOD OF CLEANING.

It has always been known that the method of cleaning a fish preparatory for salting has an important influence on the quality of the product. From the first the writer noted that the salt penetrated more rapidly through the cut flesh of fish than through a surface covered with skin. This was first noticed while following the penetration into the fish of salt containing calcium chloride. The calcium chloride produced a marked whitening of the tissue. This was observed to proceed more rapidly on the cut side of the fish than on the side covered with skin.

The common practice in rating the quality of a salted herring or alewife is to break the fish open so that the backbone is exposed. The odor of the dark red or brown spots is then observed. The experienced fish salter knows that these spots are the first parts of the fish to spoil. They are caused by the coagulation and partial decomposition of the blood. Most fish salters seem to realize that the blood is the most unstable substance contained in fish, for they rate the efficiency of different procedures in fish salting by the amount of blood that the processes "draw out." They are well aware of the fact that round fish can not be salted at as high a temperature as cut fish. Numerous fishermen have advised the writer that very little

trouble would be encountered in salting any fish if care would be taken to scrape the blood away from the backbone and then wash all the blood out of the fish.

These and other similar observations showed the importance of the mode of cleaning as a factor in fish salting. A series of experiments was, therefore, carried out for the purpose of learning which method of preparing fish for salting was the best.

COMMERCIAL METHODS OF CLEANING.

Uncut fish.—Large quantities of herring and alewives are annually salted round, or without cutting. Some of these are washed, but other fish salters do not wash their round fish.

Pipping.—When herring are salted by the Scotch method, they are pipped or gibbed. This involves the cutting of the fish at the throat so that the gills and viscera are all removed, with the exception of the milt and roe. The head is not cut off. When fish are cut in this way it is difficult to remove the blood contained in the abdominal cavity.

Beheading.—" Headless roe " fish are prepared by partially cutting off the head of a roe fish, usually river herring; then the head is pulled off in such a way that the viscera, with the exception of the roe, are pulled out. Little blood may be washed out from fish cleaned in this manner. In some cases this procedure is altered by cutting the fish down the belly in addition to beheading.

Cutting.—The greater proportion of the river herring are salted after the heads and bellies have been cut off. In most cases this is done by the cutter in one operation.

Cutting and scraping.—In some vicinities small quantities of river herring are salted after being cleaned perfectly. The heads and bellies are cut off, and then the abdominal cavity is scraped until all the blood under the backbone and all the membranes are removed. Fish cleaned in this way are usually consumed locally.

Splitting.—Larger fish, such as the mackerel, cod, haddock, cusk, and the like, are usually eviscerated and split. This is considered essential for proper salting.

EFFECT OF CLEANING ON PROTEIN DECOMPOSITION.

METHOD.

The work on cleaning was done on the river herring. Two hundred and fifty pounds of river herring were purchased from a local Albemarle Sound fisherman. These fish were iced as soon as they were received from the boat, which was about two hours after their capture. The fish were divided into 8 lots: 2 lots of 1,000 grams each were salted round; 2 other lots were pipped; 2 lots were cleaned by cutting off the heads, cutting the fish the length of the belly, and removing the entrails, with the exception of the milt and roe; and 2 lots were cleaned by cutting and scraping. The heads and viscera were removed, including the milt and roe. These fish were then well washed, and blood and membranes were scraped out of the abdominal cavity. Great care was taken in this case to remove all visible

blood, including that underneath the backbone. All the lots were then weighed out. Exactly 1,000 grams of cleaned fish were taken in each case. They were salted in dry Diamond Flake salt, which is a fine, pure, granulated salt. Three and a third kilograms of salt were used on each lot during the first packing. The following day 833 grams of salt were added to each lot of fish.

One lot cleaned in each way was placed in each of two constant-temperature compartments, which have been previously described. One of these constant-temperature compartments was regulated for 79° F. The other was set for 88° F. Both these temperatures, it will be noted, are very high for salting fish. The results of these experiments are given in Table 12.

Table 12.—Development of Amino-Acid Nitrogen in Fish Cleaned in Various Ways.[a]

Experiment No.	Method of cleaning.	Average temperature of salting period.	Weight of fresh fish.	Amino-acid nitrogen in fresh fish (4 hours).	
		°F.	Grams.	Per cent.	Grams.
BA-1	No cleaning; salted round	79	1,000	0.029	2.90
BA-2	Pipped	79	1,000	.027	2.70
BA-3	Head cut off; abdominal cavity split open; viscera removed, with exception of milt and roe.	79	1,000	.022	2.20
BA-4	Cleaned perfectly; milt and roe removed	79	1,000	.020	2.00
BA-5	No cleaning; salted round	88	1,000	.029	2.90
BA-6	Pipped	88	1,000	.027	2.70
BA-7	Head cut off; abdominal cavity split open; viscera removed, with exception of milt and roe.	88	1,000	.022	2.20
BA-8	Cleaned perfectly; milt and roe removed	88	1,000	.020	2.00

Experiment No.	Total amino-acid nitrogen at end in—				Amino-acid nitrogen formed.		Physical condition of fish.
	Fish.	Brine.	Salt.	Fish, brine, and salt.	Total.	Per kilogram fresh fish.	
	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	
BA-1	7.88	2.52	0.22	10.62	7.72	0.77	Badly spoiled; bloated.
BA-2	6.66	2.09	.29	9.04	6.34	.63	Spoiled.
BA-3	6.80	2.06	.19	9.05	6.85	.68	Do.
BA-4	3.83	1.70	.13	5.66	3.66	.37	Excellent condition.
BA-5	10.70	3.08	.35	14.13	11.23	1.12	Badly spoiled; bloated.
BA-6	7.75	2.40	.20	10.35	7.65	.76	Badly spoiled.
BA-7	7.72	2.45	.22	10.39	8.19	.82	Do.
BA-8	4.60	1.95	.14	6.69	4.69	.47	Excellent condition.

[a] In this experiment the fish were dry salted for nine days, four hours after capture, with 4.166 kilograms of Diamond Flake salt (99.78 per cent NaCl).

DISCUSSION.

The remarkable thing about this experiment is that all the fish salted were entirely spoiled except those cleaned perfectly. Even the lot of perfectly cleaned fish which was salted at a temperature of 88° F. throughout the salting period was found to be in perfect condition at the end. These fish were cooked and sampled by six persons. All pronounced them to be far superior to the commercial salt-fish product. One critic went so far as to say that they were on a par with the fresh river herring.

The results of the chemical analyses for amino-acid nitrogen in the various samples verifies these observations. Both perfectly cleaned lots ran very low in amino acids. This shows definitely that there was very little protein decomposition.

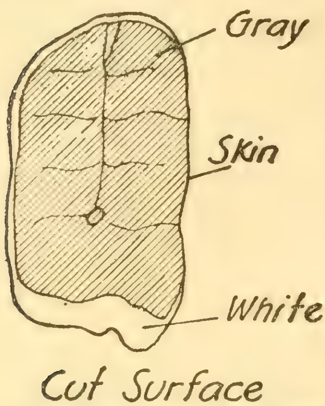

FIG. 6.—Whitening of fish after 1 day in brine.

The results given in Table 12 show that round fish spoil very easily when salted. This is a very poor way to salt fish unless the weather is very cold. On comparing BA–2 with BA–3, and BA–6 with BA–7, the writer is forced to the conclusion that it makes very little difference whether the fish are cut the length of the belly or not. It may be that those cut open, BA–3 and BA–7, were infected with bacteria during the process. At these high temperatures bacteria seem to thrive even in the presence of the salt. This was evidenced by the bloating of all the round fish, due to the accumulation of gas in the belly. This also took place in some of the pipped fish.

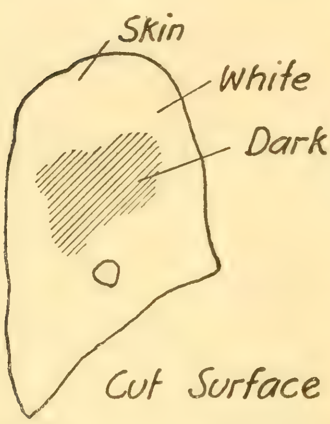

FIG. 8.—Whitening of fish after 10 days in brine.

The writer wishes to point out that the only difference between lots BA–3 and BA–4 and between lots BA–7 and BA–8 was that BA–3 and BA–7 contained milt, roe, and blood. These substances were, then, alone responsible for the spoilage. No other factor could be the cause, as the procedure in handling was the same in every respect. The question then arises as to which caused the spoilage—the blood, roe, or milt.

Previously a similar experiment had been attempted, except that the work was carried out in a commercial plant and was merely qualitative. This experiment was not quite so successful, for at a lower temperature, 80° F., some of the fish spoiled. However, the majority were in excellent condition. Upon examination, the spoiled fish revealed that the work of removal of blood before salting had been carelessly done, for blood was found under the backbone, above the vent, in every spoiled fish. None of the good fish showed traces of blood. Unfortunately, no attempt was made to salt milt and roe at high tem-

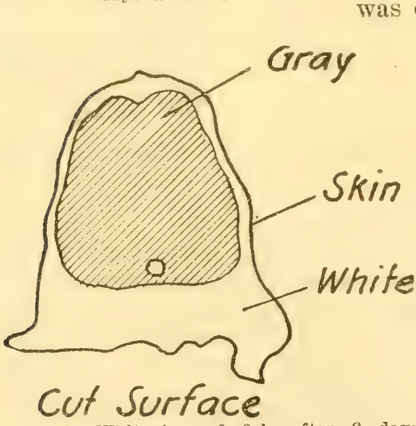

FIG. 7.—Whitening of fish after 6 days in brine.

peratures. Such experiments would show whether these substances are partially responsible for the spoilage. However, both the milt and roe must be removed if all of the blood be taken out of the fish. This is, therefore, a point of secondary importance.

ACTION OF THE SKIN.

METHOD.

The skin of fish is known to be a membrane which is more or less impermeable to the passage of dissolved salts. In the work on penetration of different salts it was noted that the penetration of salt into the fish took place much more rapidly through the cut flesh than through fish covered with skin. In the experiments on the penetration of salts containing calcium salts as impurity the passage of the salt into the fish could be followed very easily, for as the salt passed into the fish the fish became very white. This gave an easy way of estimating the rate of penetration of the salt into the different parts of the fish. The fish were cut on different days. The depth of the whitening was measured and the cross sections were drawn to scale. The diagrams are given to show how much more rapid the penetration of the salt is through the cut surface than through the skin surface.

Figure 6 shows the appearance of a cross section of a squeteague after it had been in salt for one day. The whitening had penetrated 5 mm. on the cut surface, but the whitened condition was found only 1 mm. under the skin. Figure 7 shows a cross section of the fish after it had been salted for six days. At this time the line between the light and dark portions of the section was not so distinct. Figure 8 shows a section of the fish near the end of the salting period, which was 10 days. There is yet a portion of the fish which was not white. This shows that the fish as yet was not salted uniformly throughout. The fish became entirely white throughout on the thirteenth day.

In order to gain a more accurate idea of the retardation of the penetration of the skin by the salt, some experiments were tried to determine the relative rate of penetration of salt into skinned and unskinned fish. In these experiments both skinned and unskinned squeteagues were salted in dry salt by the ordinary procedure, as described previously. The salt used contained 1 per cent of calcium chloride. This is about the purity of the average salt used for the salting of fish.

The penetration of the chlorides into the fish was determined by analyzing different sections of the fish from day to day. The procedure followed has been described in the first part of this paper. The results of the analyses of the sections from one-half centimeter to 1 cm. in depth are given in Table 13.

TABLE 13.—COMPARATIVE RATE OF PENETRATION OF CHLORIDES[a] INTO SKINNED AND UNSKINNED FISH,[b] EXPRESSED IN PER CENT OF CHLORINE IN DRY FISH.

Mode of cleaning.	Per cent chlorine after—			
	22 hours.	4 days.	7 days.	13 days.
Skinned	9.7	19.8	20.2	20.3
Unskinned	1.7	11.9	18.9	20.3

[a] Analysis of salt used, 99 per cent sodium chloride, 1 per cent calcium chloride.
[b] Inner section of fish, ½ to 1 cm.

DISCUSSION.

These data show that salt penetrates skinned fish at approximately double the speed it enters unskinned fish. Therefore, skinned fish may be salted in about one-half the time required for unskinned fish. Of course, it is not practical to skin most fish before salting; but these results show the great advantage gained in splitting a fish wherever this procedure may be followed. In hot climates the length of the salting period, the period of danger, may be cut in two.

St. Johns River shad are successfully salted in Florida by the present methods. Attempts at salting St. Johns River alewives have repeatedly failed. The reason for the successful salting of the shad may be because the shad are split and washed before salting. The alewives are salted without splitting. Due to this splitting, the salting period of the shad may be shorter than the salting period for the alewives.

PRACTICAL APPLICATIONS.

This work on the methods of cleaning proves beyond doubt that the chief cause of spoilage of fish during salting in hot weather is the decomposition of the blood contained in the fish. This seems to show that the problem of salting fish in warm climates is in reality a very simple one.

What must be done, then, in order to salt the alewives of the Florida rivers successfully during warm weather? The only change from the North Carolina method necessary is that greater care must be taken to remove every bit of blood and viscera. This can be accomplished if the roe and buckroe are removed in the cleaning operation. These may be canned profitably. After cleaning, the under side of the backbone should be scraped so that all the blood and membranes in the abdominal cavity are removed. A 20-penny nail is an instrument that can be conveniently used for scraping the backbone. The head of the nail may be ground thinner on an emery wheel. This operation sharpens the head so that it cuts out the membranes without much pressure. A single operator can easily scrape out a thousand fish in an hour. After scraping the fish they should be soaked in cold water for at least one-half hour. This dissolves practically every trace of the blood. It is good practice to wash the fish in a false-bottomed wheelbarrow with a powerful stream of water. After soaking the fish they should be packed in dry salt.

The above method of cleaning fish pays, even though the salting is done in a climate where this procedure is not essential; for extra washing and cleaning produces fish of much finer quality than those produced by the old methods. The up-to-date canner is using every possible precaution to avoid the presence of blood in his canned fish, so as to produce an entirely white fish. The well-washed fish when salted does not undergo a discoloration due to the presence of blood. The strong taste of salted river herring is eliminated in the washing.

Perfectly cleaned fish, salted at high temperatures, should bring a better price than the old dirty-looking product produced in the North. The public would soon learn of their improved quality.

All large fish salted in warm weather should be split, and care should be taken to remove the blood. This should be less difficult in

the case of the split fish, for the blood would be almost entirely exposed to view. The splitting would also greatly decrease the length of the salting period, due to the more rapid penetration of the salt.

SUMMARY.

River herring, cleaned by various methods, were salted at very high temperatures. All save those from which all roe, milt, and blood had been removed spoiled. Perfectly cleaned river herring were salted at a temperature of 88° F. It was concluded, therefore, that the chief cause of spoilage of fish during salting is the decomposition of the blood remaining in the fish. The rate of penetration of salts into skinned fish was compared with the rate of penetration of salt into fish before skinning. It was found that salt penetrates skinned fish at about double the speed it enters unskinned fish. This proves the great value of splitting fish preparatory to salting. These results are of great value in a practical way, for they show that if proper care be taken in the cleaning of fish, it is probable that they may be salted in any hot weather anywhere in the United States. With only an hour's extra work per thousand of river herring, these fish may be prepared for salting in hot weather. The salt-fish product prepared by this extra care in cleaning is of much better quality than the commercial salt fish.

IV. INFLUENCE OF FRESHNESS IN SALTING FISH.

INTRODUCTION.

Staleness in fish is undesirable. However, more or less staleness is always unavoidable. It seems reasonable to suppose that during colder weather staler fish may be salted than during hot weather. Few data in the literature concerning the limits of freshness are of value, for there are no standard methods of judging staleness. Most writers on the subject have used various physical criteria to estimate the relative freshness of stale fish. Some of the physical qualities that have been used as criteria are: 1. The presence, or absence, of a reddish discoloration on the ventral aspect of the backbone. 2. The odor. 3. The manner in which the flesh separates from the backbone. 4. The appearance of the abdominal walls.

The use of such criteria leaves too much to the judgment of the investigator. In other words, the personal equation plays too prominent a part. There are really but two ways of fairly stating the degree of freshness of any fish. The first and most accurate way is to give the number of hours since the fish was caught and the temperature at which it has stood for that time; the other is to state its chemical analysis. The per cents of amino-acid nitrogen and of ammoniacal nitrogen are particularly indicative of the condition of the fish.

In experiments previously described the number of hours the fish had been out of the water before they were salted has been given wherever possible. Since it was impossible to obtain live fish, standard freshness was considered as a fish transported in a boat at atmospheric temperature for two hours. Then the fish were iced and

cleaned, and after being iced for two hours were salted. There was, of course, the error caused by the difference in temperatures of different days. However, since at no time was the atmospheric temperature above 80° F., little decomposition took place in the two hours.

Since fish spoil so quickly during hot weather, an attempt was made to find out how fresh they must be in order successfully to salt them at various temperatures. This should show whether the cause of spoilage during salting in hot weather was through the use of stale fish.

Insufficient work has been accomplished to obtain any very definite data concerning the necessary freshness of fish for salting. Unfortunately, the work was carried out at too high temperatures, and all of the stale lots of fish spoiled.

METHOD.

Eighty pounds of glut herring (*Pomolobus æstivalis*) were obtained after they had been out of the water for four hours. During this time they had been kept at approximately 60° F. They were divided into five lots and kept at 64° F. One lot was immediately cleaned, washed, and dry salted according to the usual method. After 16 hours a second lot was cleaned, washed, and salted; and after 24 hours a third lot was cleaned, washed, and salted. The first three lots were cleaned by beheading and eviscerating the fish, without removing the milt and roe. After 33 hours the two remaining lots were cleaned and salted. One of these lots was cleaned in the same manner as that of the first three. The other was cleaned more perfectly. The milt and roe were taken out, and the blood was scraped out from under the backbone. These fish were given an extra washing.

The five lots of fish were allowed to stand 15 days (from day of catch) before the analyses were made. For this reason the amounts of amino acids found were higher than in comparative lots which were analyzed at the end of nine days. The total amounts of amino-acid nitrogen formed were computed as before. The results are given in Table 14.

TABLE 14.—DEVELOPMENT OF AMINO-ACID NITROGEN IN FRESH AND STALE FISH AT 64° F.[a]

Experiment No.	Time between capture and salting.	Method of cleaning.	Weight of fresh fish.	Amino-acid nitrogen in fresh fish.	
	Hours.		*Grams.*	*Per cent.*	*Grams.*
Z-1	4	Head and viscera removed, with the exception of the milt and roe; washed once in ice water.	6,000	0.022	1.32
Z-2	20	do	6,000	.022	1.32
Z-3	28	do	6,000	.022	1.32
Z-4	35	do	5,500	.022	1.21
Z-5	35	Head, blood, and all viscera removed; washed twice in ice water.	5,500	.020	1.10

[a] In this experiment the fish were dry salted for 15 days with 2,200 grams of chemically pure sodium chloride.

TABLE 14.—DEVELOPMENT OF AMINO-ACID NITROGEN IN FRESH AND STALE FISH AT 64° F.—Continued.

Experiment No.	Total amino-acid at end in—				Amino-acid formed.		Physical condition of fish.
	Fish.	Brine.	Salt.	Fish, brine, and salt.	Total.	Per kilogram fresh fish.	
	Grams.	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*	
Z-1	5.06	1.19	0.51	6.76	5.44	0.91	Good.
Z-2	7.28	1.51	.43	9.22	7.90	1.32	Tainted.
Z-3	7.86	1.53	.44	9.83	8.51	1.42	Spoiled.
Z-4	8.54	1.60	.40	10.54	9.33	1.70	Badly spoiled.
Z-5	4.54	1.51	.30	6.35	5.25	.95	Tainted.

DISCUSSION.

Sixty-four degrees Fahrenheit is very close to the maximum temperature for salting fish containing blood, milt, and roe. For this reason all the stale fish spoiled. However, a comparison of the results obtained in lots Z–4 and Z–5 shows quite plainly that the roe, milt, and blood are the first portions of a fish to spoil at lower temperatures. This suggests a method of dealing with all stale fish. Evidently much staler fish may be salted if they are perfectly cleaned than if they contain blood, milt, or roe.

Two other experiments at higher temperatures were tried which verify these results. The other experiments were conducted at 75 and 79° F., respectively, which temperatures were so high that all the fish spoiled. These experiments were almost exact duplicates of the experiments reported in Table 14; hence they will not be described in detail. The fish were cleaned and salted at 4, 10, 14, and 28 hour intervals. Four lots of fish were kept at 75° and four at 79° during this period. The 4, 10, and 14 hour lots were only partially cleaned, the roe, milt, and blood being left in and the fish washed but once. The 28-hour lots were cleaned perfectly, the roe and milt being removed and the blood scraped out. Lot Z–5 was treated in the same way. All of these lots were salted in brine. The results of the calculations of the total amounts of amino-acid nitrogen formed are given in Table 15.

TABLE 15.—DEVELOPMENT OF AMINO-ACID NITROGEN IN FRESH AND STALE FISH AT 75 AND 79° F.[a]

Experiment No.	Time between capture and salting.	Method of cleaning.	Average temperature of salting period.	Weight of fresh fish.	Amino-acid nitrogen in fresh fish (4 hours).	
	Hours.		*° F.*	*Grams.*	*Per cent.*	*Grams.*
DA-8	4	Head and viscera removed with exception of milt and roe. Washed once in ice water.	75	5,000	0.022	1.10
DA-11	10	....do	75	5,000	.022	1.10
DA-12	14	....do	75	5,000	.022	1.10
DA-14	28	Head and all viscera removed. Blood washed out.	75	5,000	.020	1.00
DA-1	4	Head and viscera removed with exception of milt and roe. Washed once in ice water.	79	5,000	.022	1.10
DA-4	10	....do	79	5,000	.022	1.10
DA-5	14	....do	79	5,000	.022	1.10
DA-7	28	Head and viscera removed. Blood washed out.	79	5,000	.020	1.00

[a] In this experiment the fish were salted for nine days in 5 liters of brine prepared from Diamond Flake salt (NaCl 99.78 per cent) and 1 kilogram of this salt.

Table 15.—Development of Amino-Acid Nitrogen in Fresh and Stale Fish at 75 and 79° F.—Continued.

Experiment No.	Total amino-acid nitrogen at end in—			Amino-acid nitrogen formed.		Physical condition of fish.
	Fish.	Brine.	Fish, brine, and salt.	Total.	Per kilogram fresh fish.	
	Grams.	*Grams.*	*Grams.*	*Grams.*	*Grams.*	
DA-8	2.46	2.09	4.55	3.45	0.69	Tainted.
DA-11	3.50	2.11	5.61	4.51	.90	Spoiled.
DA-12	3.36	2.45	5.81	4.71	.94	Do.
DA-14	2.15	2.51	4.66	3.66	.73	Tainted.
DA-1	3.00	2.00	5.00	3.90	.78	Spoiled.
DA-4	3.43	2.56	5.99	4.89	.98	Do.
DA-5	3.64	2.71	6.35	5.25	1.05	Badly spoiled.
DA-7	3.34	2.94	6.28	5.28	1.06	Spoiled.

Comparisons of the analyses of lot DA-12 with the analyses of lot DA-14 and of DA-5 with DA-7 show that thorough cleaning permits the salting of staler fish, for there was no more decomposition in the case of the thoroughly cleaned 28-hour fish than in the case of the 14-hour fish containing milt, blood, and roe. A comparison of DA-8 with DA-11 plainly indicates that at high temperatures great care must be taken to obtain absolutely fresh fish for salting. Evidently there is a temperature somewhere between 50 and 60° F., above which fish can not be kept for any length of time without spoiling.

GENERAL CONCLUSIONS.

I. *Influence of impurities in salt in salting fish.*—Calcium and magnesium salts and sulphates, as impurities in salt, retard the penetration of salt into fish. Salts containing these impurities, therefore, cause fish to spoil during salting at a lower temperature than salts not containing such impurities. Of these three impurities, calcium is the only one present in commercial salts in large enough quantities to have an appreciable effect on the quality of the salt.

II. *A comparison of the efficiency of brine and dry salt for salting fish.*—Fish packed in dry salt, without any addition of brine, may be kept at a higher temperature than fish salted in brine, for less decomposition takes place if no brine be added. The dry-salt method is the more economical method of the two.

III. *Influence of method of cleaning fish for salting.*—The removal of all blood and viscera, including roe and milt, is absolutely essential for the salting of fish at high temperatures. Blood spoils at a temperature at least 25° F. lower than the spoilage temperature of the flesh of fish.

IV. *Influence of freshness in salting fish.*—During warm weather freshness of fish is essential to successful salting. However, much staler fish may be salted if all blood, roe, and milt are removed in cleaning.

RELATIVE IMPORTANCE OF FACTORS.

The predominant factor in controlling the qualities of the salt-fish product and the maximum temperature of salting is the thorough cleaning of the fish, so as to effect the removal of all viscera and blood. If fish are perfectly cleaned, it appears possible to obtain a white, sweet-tasting salt fish at any American summer temperature. If the fish are not perfectly cleaned, it is impossible to salt them at any temperature averaging above 70° F. by any known method of salting, regardless of the kind of salt used or the mode of application of the salt.

The factor of second importance is freshness. When the temperature of the fish is above 70° F., the fish must be salted the same day that they are caught, if they are to be successfully cured. At lower temperatures this factor is of less importance, until at 32° F. this factor is practically eliminated. That is to say, at this temperature fish may be kept for long periods and yet be salted successfully.

Next in line of importance comes the method of application of salt. Fish iced for two days (see p. 36) may be salted at about 4° higher temperature by the application of dry salt rather than brine. Fine salt must be used for small fish.

Of next importance is the composition of the salt. This factor may be easily controlled by the purchase of salt of known purity. This affects the physical qualities of the salt fish. Commercial salts high in calcium lower the maximum temperature at which fish may be salted by any known method.

PRACTICAL APPLICATIONS OF RESULTS.

The probability that fresh fish may be salted without danger of spoilage in any climate in the United States is of considerable importance. The only requirements for salting fish at high summer temperatures are:

1. All viscera and blood must be removed in cleaning.
2. All large fish must be split.
3. The fish must be salted in a reasonably fresh condition.
4. No brine should be added in salting.
5. Salts low in calcium must be chosen.

These requirements do not involve great changes in the methods of salting now employed. In reality they merely require more perfect cleaning and greater care in the selection of salt. The fish of our southern waters that are as yet not utilized may be salted without any difficult changes in the present methods, and thus a great saving may be effected.

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FROGS: THEIR NATURAL HISTORY AND UTILIZATION

By A. H. Wright

Cornell University

Appendix VI to the Report of the U. S. Commissioner of Fisheries for 1919

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35286°—21——17

BULLFROG (RANA CATESBEIANA). DESIRABLE SPECIES; ADULT, NATURAL SIZE.

FROGS: THEIR NATURAL HISTORY AND UTILIZATION.

By A. H. Wright, *Cornell University.*

INTRODUCTION.

From time to time since Seth Green's day efforts have been made by our best fish-culturists to raise frogs; but in all this period no definite successful mode of procedure has been evolved. Some of these workers became[a] "skeptical" and from "personal study and experience" were made "unbelievers." Others wrote about frog culture in an effort to supply information when they had nothing to give. Still others gave what little they had of value and commented:[b] "We are just as glad as you are that this bullfrog story is finished." Finally, the most serious group[c] announced complete success in "their preliminary experiments," and their efforts were sincerely appreciated by both the public and the culturists; but these experiments were abandoned.

Several writers have taken advantage of the public's intense desire for knowledge on this subject and have perpetrated all sorts of hoaxes and fakes on the credulity of their readers. Periodically some newspapers write of mythical "frog farms" for space fillers. Magazines occasionally accept similar articles, which should never have seen the light, and at present one must needs be on guard against the half-digested, hastily issued, worthless literature which would lead the uninitiated to believe the problem is entirely solved and that frog culture is wholly feasible. Too frequently the public seems to be fed on prettily written, fanciful speculation, and, as a consequence, frog culture receives much undeserved ridicule.

Notwithstanding all this deception and lack of definite procedure and in spite of the fact that little of importance has appeared to encourage it, the public continues to be vitally interested in the possibilities of frog culture. Many a reader of "The Virginian," after the dissertation on the "frawg business," has asked if there is really anything in it. The experiments which were started several years ago at the Pennsylvania State fish hatcheries aroused astonishing and widespread public comment. The commissioner of fisheries of Pennsylvania said:[d]

> The interest was confined not to Pennsylvania alone but extended to nearly all parts of the United States. Newspapers, trade papers, and magazines commented on

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[a] Mather, Fred: Modern fish culture in fresh and salt water, pp. 301, 302. New York, 1900.
[b] Dyche, L. L.: Ponds, pond fish, and pond-fish culture, p. 158. State Department of Fish and Game. Kansas. Topeka, 1914.
[c] Report, Department of Fisheries of Pennsylvania from December, 1904, to Nov. 30, 1905, p. 51. Harrisburg, 1906.
[d] Loc. cit. pp. 51, 52.

our work in this direction at considerable lengths, and all approvingly. Letters from private citizens were received from nearly every State in the country asking for further information. These were followed by communications from fish commissions and fish-culturists in the same vein.

In former years, at the sessions of the fishery and fish-cultural societies, frog culture was a frequent topic of inquiry, though not of extended discussion. To-day the U. S. Bureau of Fisheries receives countless inquiries and requests for literature, for information, and for possible sources of breeding stock, and this report is written to supply the information which must precede all careful experimental work on frog culture.

The difficulties encountered in many of the preceding efforts have arisen from lack of knowledge of the natural history of our native species of frogs. Such knowledge is an absolutely necessary premise to intelligent, successful endeavor. Often the best of the previous experimenters were not sure whether they had bullfrog or leopard-frog spawn, and thought that possibly the bullfrog bred twice a year when it breeds but once a year, or considered that bullfrog tadpoles transformed the same year they were hatched or in the following spring, neither of which conditions obtains. A careful critical study of most of the previous efforts reveals uncertainties of this sort, one of the most marked of which is the lack of positively identified stock with which to begin. Here, as in every other farming enterprise, it is necessary to have the seed or stock true to name. Fortified with this precaution and equipped with some of the cardinal points in the life history of the species to be raised, the prospective frog culturist stands a far better chance of success than in a blind "hit-or-miss" endeavor.

COMMERCIAL FROG HUNTING.

SOURCE OF SUPPLY.

The market is yet solely reliant upon the natural supply of frogs. Of this industry, previous to 1900, F. M. Chamberlain, of the U. S. Bureau of Fisheries, remarked as follows:[a]

The business of taking frogs for market has greatly increased in recent years. It is now carried on in all sections of the United States and is of economic importance in about 15 States, while in nearly all the remaining States and Territories frogs are taken for local or home consumption [in quantities] of which it is impossible to get a statistical account. The States supplying the largest quantities for the markets are California, Missouri, New York, Arkansas, Maryland, Virginia, Ohio, and Indiana. More frogs are taken in New York than in any other State, but on account of their comparatively small size their value is less than in Missouri and California. The Canadian Province of Ontario also yields a rather large supply of market frogs. As ascertained by inquiries of the U. S. Fish Commission, the annual catch in the United States is but little less than 1,000,000, with a gross value to the hunters of about $50,000. The yearly cost of frogs and frog legs to the consumers is not less than $150,000.

The localities in which especially important frog hunting is done are the marshes of the western end of Lake Erie and Lewis and Grand Reservoirs, in Ohio; the marshes of the Sacramento and San Joaquin Rivers, Calif.; the valley of the Kankakee River, Ind.; Oneida Lake, Seneca River, and other waters of northern New York; and the St. Francis River and the sunken lands of the Mississippi River, in Arkansas and Missouri.

* * * The prices received for frogs vary greatly and depend on the condition of the market, the size of the frogs, and the locality. Dressed legs yield the hunters from 12½ to 50 cents a pound, and live frogs from 5 cents to $4 a dozen. In the Kankakee Valley, Ind., for example, the prices received by the hunters are 75 cents a

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[a] A manual of fish-culture based on the methods of the U. S. Commission of Fish and Fisheries. Revised edition, pp. 252, 253. U. S. Commission of Fish and Fisheries. Washington, 1900.

dozen for large frogs, 10 cents a dozen for medium-sized frogs, and 5 cents a dozen for small frogs, while in San Francisco the market price is $3 to $4 a dozen.

To the above list of States yielding a considerable supply of frogs in 1900 there should be added Illinois and Minnesota. Of the latter C. H. Townsend writes:[a]

The most valuable product of these fisheries is the frog, the value of the catch in 1899 constituting nearly one-fourth of the entire fishery yield of the State. The species taken is the "meadow frog," which is quite small, the average weight being between 1 and 2 ounces each. * * * Professional frog catchers are said to make from $5 to $10 per day during the best of the season. Most of the catch is shipped direct to Chicago.

The frog industry in this State was started about 1895, and has grown in importance. In 1899 over $5,000 worth were taken in the vicinity of Minneapolis alone. Litchfield was the next greatest frog-producing center in the State that year. In 1900 this industry had shifted from the latter place to Smith Lake, where one dealer purchased over $5,000 worth during the year.

By the year 1900, then, the following 10 States contributed a large proportion of the market frogs of the country: California, Missouri, New York, Arkansas, Minnesota, Illinois, Maryland, Virginia, Ohio, and Indiana.

In 1908, 250,000 pounds of frogs' legs, with a value of $42,000, were reported for the whole of the United States.[b] The 13 States which furnished this total were:

States.	Quantity.	Value.	States.	Quantity.	Value.
	Pounds.			*Pounds.*	
Missouri	67,000	$11,000	Tennessee	5,000	$1,000
Minnesota	66,000	7,900	Ohio	4,000	600
Louisiana	38,000	4,500	Virginia	3,000	700
Arkansas	27,000	4,000	Iowa	2,500	300
Illinois	25,000	6,800	Delaware	1,900	700
Wisconsin	14,000	2,600	Maryland	1,000	500
North Carolina	5,400	900			

At least 8 of these 13 States are along the Mississippi River, and 6 of them fall wholly within that district. The Mississippi River division contributed 193,000 pounds; the Gulf of Mexico division, 38,000 pounds; the Great Lakes division, 17,000 pounds; and the Atlantic coast division, 11,000 pounds. Thus it is apparent that the Mississippi River States are becoming more important in commercial frog hunting. Before 1900 Missouri and Arkansas were the principal States in this region furnishing frog legs. By 1900 Minnesota and Illinois were added to the list, and by 1908 Louisiana, Wisconsin, Tennessee, and Iowa began to contribute appreciable quotas.

In the previous summation New York does not appear, but in 1915 and 1916 in the Oneida lake region the following is noted:[c]

[One firm conducted] a gross business of about $15,000 per year in frogs alone. One customer bought between June 1, 1915, and March 1, 1916, $1,687.50 worth of frogs' legs. When sold per hundred, live weight, large and small, the price ranges from 30 cents to $1.50 or averages $1.05. The legs sell per pound, large and small, from 10 to 50 cents, and average 35 cents per pound. An expert can dress between 1,500 and 1,600 frogs per hour, but an average rate is about 1,000 per hour.

[a] Townsend, C. H.: Statistics of the fisheries of the Mississippi River and tributaries. Appendix to Report of the Commissioner, U. S. Commission of Fish and Fisheries for 1901, p. 726. Washington, 1902.

[b] Fisheries of the United States, 1908, pp. 26, 28, 33, et seq. Washington, 1911.

[c] Adams, Chas. C., and Hankinson, T. L.: Notes on Oneida Lake fish and fisheries. Transactions, American Fisheries Society, Vol. XLV, No. 3, June, 1916, p. 163. New York.

METHODS OF CAPTURE.

There are various methods of capturing frogs. The boy's favorite device is the fish pole, with the line baited with red cloth, worms, grasshoppers, or other insects; and this method is yet frequently employed by the market hunter. A more common method, however, is clubbing. Many of us as boys used to choose a good strong club about walking-stick length. With this instrument we skirted the edges of the swamps, lakes, or marshy creeks in the spring or early summer, traversed the clover or hay fields of the uplands in July about cutting time, or hunted in the wet lowlands a little later. Some of the men and boys occasionally put nails in the end of the club, but this more cruel method avails little. The frogs which were killed were put into a bag or strung on a cord by loops tied about their loins. They were dressed immediately after the trip.

[In Minnesota][a] frogs are also taken by sticks and gunny sacks. In using sticks the frogs are usually killed and then sold in a dressed condition for food. Gunny sacks in a wet condition are used in their capture by being thrown over the frogs. Frogs are kept alive for market in gunny sacks placed in running water and covered with hay or straw to keep out the frost.

Some expert froggers are very adept at catching them alive by hand. A frog catcher will hold one hand over or in front of the prey to attract its attention and capture the game by a sudden movement of the other hand.

Several methods are based on the migration of the frogs in the fall or spring. In the central New York region in late September, through October, and even in November, frogs are frequently encountered working their way down the hills toward the swamps around or at either end of some of our Finger Lakes. Many reach the swamp in the fall, and many winter in the ravines and enter the swamps in the spring. In many cases State roads or other similar and partial barriers skirt our lakes—that is, steam railroads, electric railways, etc.—and the frog catchers make use of these. A calcium-carbide can or a barrel placed at the swamp end of a culvert may yield numerous frogs which are traveling down the ravines, and the swamps or ditches dug at the base of the hills and at the swamp's border may give good returns.

[In Minnesota][a] frogs are caught in various ways, but chiefly in pits dug between sloughs and the adjoining high grass. The season for their capture in this manner is usually in the fall, when they are returning to the water. These pits are about 3 feet long, 2 feet wide, and 2 feet deep.

There are many other variations of this pit, posthole, ditch, or excavation method. In Oneida Lake an outgrowth of the pit and can methods is the use of screens.

[This form of capture][b] is used in the fall when the frogs migrate from the fields and swamps toward the lake for hibernation. This migration is not regular, it takes place mostly at night, particularly during warm rains, after a light frost. Taking advantage of this migrating behavior, cheesecloth screens, about 18 inches high, supported by sticks, are placed along the shore to intercept the migrating frogs. At intervals of two or three rods nail kegs, carbide cans, or posthole-like excavations entrap the frogs which, failing to surmount the screen, wander along it and fall into the traps. The frog catcher has only to collect the frogs from those traps. Late in the season one may find various sized frogs, mice, and other small mammals drowned and frozen in these small wells.

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[a] Townsend, C. H.: Loc. cit., p. 726.
[b] Adams, C. C., and Hankinson, T. L.: Loc. cit., pp. 161, 162.

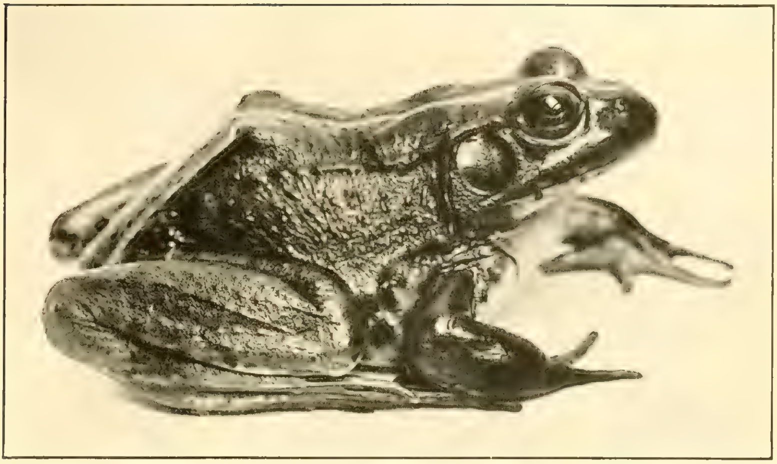

FIG. 1.—GREEN FROG (RANA CLAMITANS). DESIRABLE SPECIES; NATURAL SIZE.

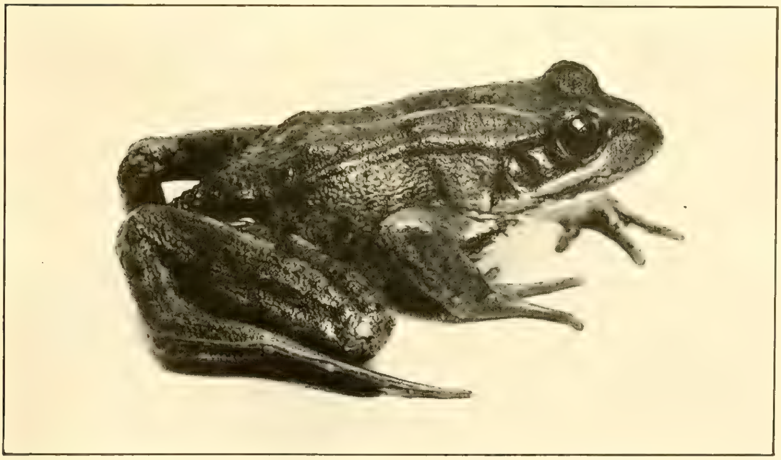

FIG. 2.—"WESTERN BULLFROG" (RANA AURORA). DESIRABLE SPECIES; NATURAL SIZE.

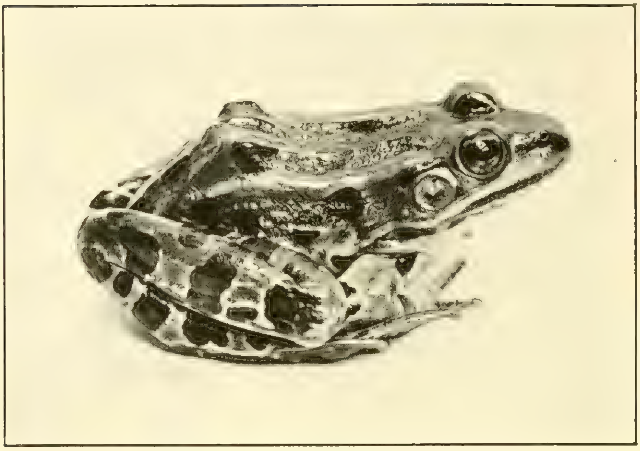

FIG. 1.—LEOPARD FROG (RANA PIPIENS). DESIRABLE SPECIES; NATURAL SIZE.

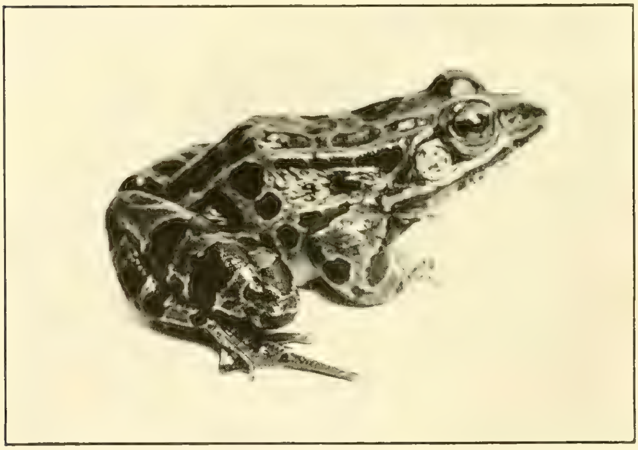

FIG. 2.—PICKEREL FROG (RANA PALUSTRIS). DESIRABLE SPECIES; NATURAL SIZE.

The screens have to be placed far enough back from the lake shore to avoid water rising too near the surface and thus destroy the traps. On the swampy ground the holes are similarly obliterated by the water. To overcome this difficulty, Mr. A. W. Thierre, of Lower South Bay, has devised a trap of woven wire screen; with a one-half-inch mesh. If this trap was placed at an opening in the screen, which is not the case, it would allow the undersized frogs to escape and to reach the lake and find proper winter quarters, while the screens tend to destroy both the smaller kinds of frogs and immature individuals of the larger species. This wire trap has an inclined surface up which the frogs crawl, and from which they fall into the trap cavity, and from which they seldom escape. Thierre also uses a large minnow box to store his frogs until delivery to the dealers.

By means of the screens and traps a single night's catch may amount to about 500 pounds, from about a half mile of screen in a good locality. As much as $70 has been paid for a single catch.

In many regions, as in central New York and elsewhere, the professionals come to know where the frogs hibernate and often dig them out of the mud in large numbers. In the Erie Canal, after the water is withdrawn, many frogs are taken from the mud or even from beneath the ice of some of the pools.

A favorite method of capture at night is to use a bull's-eye or any form of bright light. The frogs are dazed and in most cases can be caught by hand or approached near enough for their easy dispatch. Sometimes in the deeper waters and swamps two men are needed for this form of capture, one to row the boat and the other to locate and shoot the prey. The lantern may be on the prow of the boat, carried in the hand, or worn on the head, as with alligator hunters. The rifle and spear and gig are used mainly in Illinois, Arkansas, Missouri, and Tennessee. The spear may be one of several sorts, three-pronged or single, or merely a nail or a straightened fishhook in the end of a pole.

COMMERCIAL FROGS.

DESIRABLE SPECIES (PLS. I, II, AND III).

The six eastern edible species fall into two groups of three each:

Those with more or less uniform dorsal coloration on the back, and with an eardrum larger than the eye in the male, namely, the green frog (*Rana clamitans*), the bullfrog (*R. catesbeiana*), and the southern bullfrog (*R. grylio*).

Those which are blotched or spotted on the back and with the ear of the male not larger than the eye, namely, the leopard frog (*Rana pipiens*), the southern leopard frog (*R. sphenocephala*), and the pickerel frog (*R. palustris*).

In the western States three species enter into commercial catches. They are the yellow-legged frog (*Rana boylii*); the western frog (*R., pretiosa*); and the "western bullfrog" (*R. aurora*).

The above nine forms are all true frogs (Rana) which have teeth on the upper jaw, no adhesive, enlarged disks on the ends of the fingers and toes, and no large parotoid gland back of each eye. Most of them are smooth of skin, and all reach an adult length of at least 3 inches, not counting the hind legs.

EASTERN SPECIES.

Green Frog.—The green frog (Pl. II, fig. 1) is larger than a leopard frog and has two ridges down its back. The forward upper parts are bright green; the posterior region, brown or olive. The under

parts are white, with some marbling; in the male the throat is yellow. This species reaches $3\frac{1}{2}$ to 4 inches or more in length and extends in range from the Gulf of Mexico to Hudson Bay, occurring in practically all of eastern North America.

Bullfrog.—The bullfrog (Pl. I) is much larger than the green frog, and the two are often confused. The bullfrog has no ridges down either side of its back. On its upper parts it may vary from yellowish green to a dark brown, while its under parts are yellowish white, with some mottlings. In size it may reach 8 inches, and its range is from eastern North America to the Rockies.

The Southern Bullfrog.—The southern bullfrog is quite similar to the common bullfrog and varies from brownish olive to bone brown or blackish brown above, with some prominent, scattered black spots. The under parts often have a network of black or brown and yellow, one of the most striking ventral colorations of any North American frog. This species has a more pointed snout than the bullfrog, possesses a narrower head (measured at the eardrums), and has all the hind toes except the fourth proportionally longer than the same toes of the bullfrog. Of this form, the author has taken no specimens over 5 or 6 inches in length, while the extreme for the bullfrog may be much more. The known range of the southern bullfrog is in the extreme southeastern United States.

Leopard Frog.—The leopard frog or meadow frog (Pl. III, fig. 1), the most widespread and most common form of North America, has all the under parts white or whitish. On either side of the back is a prominent fold, which is narrower and higher than in the pickerel frog. Between these two main folds sometimes there are other smaller folds. The spots between the two folds are irregular in outline and in position, are not necessarily opposite, and occupy less space than the background color, which varies from bronze to green. The spots below the lateral fold are less regularly placed and never so large as in the pickerel frog. The leopard frog reaches a length of $3\frac{1}{2}$ to 4 inches and is found from the Sierra Nevada Mountains eastward and from the extreme north to Mexico.

The Southern Leopard Frog.—The southern leopard frog is very similar to the common leopard frog and varies from it in a very few characters. It usually has a distinct white spot in the middle of the eardrum, unlike the leopard frog, in which it is generally absent. Then, the head of the southern form is contained 2.5 times, or less than 3 times, in the length of the head and body combined, while the common form has it 3 to 3.5 times. Furthermore, in the southern species the snout is acuminate or pointed and is contained about 1.5 times in the head, while in the other form the snout is less pointed and is contained 2 or more times in the head. This species may reach the size of a common meadow frog and occurs in the southern States.

Pickerel Frog.—The pickerel frog (Pl. III, fig. 2), in life has the under parts of the legs and belly orange yellow. On either side of the back is a broad, low fold of skin. Between these folds there are two regular, more or less opposite, rows of dark, squarish spots, which occupy far more of the back than the light-brown, ground color. Below each back fold the spots are larger and more regular than in the leopard frog. The pickerel frog reaches a length of 3 to $3\frac{1}{2}$ inches and is found from the central plains to the Atlantic seaboard and from the Gulf of Mexico to Hudson Bay.

FIG. 1.—SPADEFOOT (SCAPHIOPUS HOLBROOKII). POSSIBLE SPECIES; NATURAL SIZE.

(After Overton. Mus. Brooklyn Inst. Arts and Sci. Sci. Bull., Vol. 2, No. 3.)

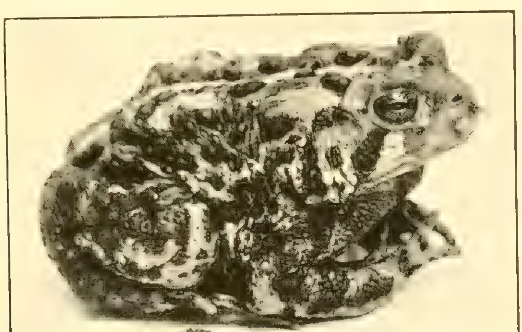

FIG. 2.—COMMON TOAD (BUFO AMERICANUS). POSSIBLE SPECIES; NATURAL SIZE.

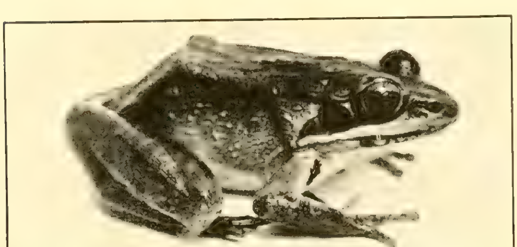

FIG. 3.—WOOD FROG (RANA SYLVATICA). POSSIBLE SPECIES; NATURAL SIZE.

WESTERN SPECIES.[a]

The western species are somewhat confusing. At present Camp (1917) recognizes three species, while Cope (1889) held there were four.[b] The three species are *Rana boylii*, the yellow-legged frog; *Rana pretiosa*, the western frog; and *Rana aurora* (both aurora and draytoni), the so-called "western bullfrog."

Yellow-Legged Frog.—The yellow-legged frog has the ear or tympanic region not darker than the rest of the head, possesses no red in its coloration, and has the fold along the upper lip colored like the rest of the body. These creatures are 2½ to 3½ inches in length and occur in California. They have been less used for food because of their skin secretions.

Western Frog.—In the western frog the hind leg, when brought forward along the body, has the inner angle of the bent heel reaching to the eye or nostril, but never beyond. The back and top of the head has prominent, inky-black spots. This species attains a length of 3 to 4 inches and extends from Nevada and northern California throughout Oregon and Washington to Alberta and east into Montana, Wyoming, and Utah.

"Western Bullfrog."—The "western bullfrog" (Pl. II, fig. 2), unlike the western frog (*R. pretiosa*), has no inky spots on the back and top of the head, and the heel reaches to or beyond the nostril. These creatures may have their skin very smooth (*aurora*) or roughened (*draytoni*), have the lateral folds of the back indistinct (*aurora*) or prominent (*draytoni*), possess unspotted or dotted backs (*aurora*) or have regularly placed, light, centered spots (*draytoni*), be medium, 3 inches long (*aurora*), or large, 4 inches (*draytoni*). The "western bullfrog" extends from Puget Sound to Lower California.

These last two forms, the western frog and the "western bullfrog," usually have the tympanic region darker than the rest of the head, red often present in the coloration, and the fold along the upper lip usually white or lighter than the rest of the head.

POSSIBLE MARKETABLE SPECIES (PL. IV).

There are several species of true frogs which are smaller, such as the wood frog and its relative, the northern wood frog; the mink frog (*Rana septentrionalis*) of extreme northeastern United States and Canada; the carpenter frog (*R. virgatipes*) of New Jersey and the Carolinas; or the local and rare gopher frog (*R. æsopus*) of Florida. It will, doubtless, never become feasible to use these species in frog culture.

The *wood frog* (Pl. IV, fig. 3) is either light or reddish brown above, with a darker brown streak or mask on either side of the head. Underneath it is a glistening white. The *northern wood frog* is like the wood frog; but the length of the hind leg to the heel does not exceed the combined length of the head and body, while in the

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[a] The author is indebted to Charles Lewis Camp's "Notes on the systematic status of the toads and frogs of California" (University of California Publications in Zoology, vol. 17, No. 9, pp. 115-125, Feb. 3, 1917, University of California Press, Berkeley) for most of what follows on the western forms. The author also has specimens from the Pacific coast collected by Profs. J. C. Bradley, W. A. Hilton, A. C. Chandler, and the writer.

[b] Cope, E. D.: The Batrachia of North America. U. S. National Museum Bulletin No. 34, 432–447 Washington, 1889.

wood frog it does. The *mink frog*, like the bullfrog, has no fold of skin on either side of the back, one joint of the fourth toe is free of web, and the male has the eardrum larger than the eye. This form is small, the body being from 2 to 3 inches in length. The mink frog is light olive with irregular spottings on the posterior back and sides, with the hind legs spotted or banded. The *carpenter frog* has no lateral folds, two joints of the fourth toe are free, and the animal is brownish, with four yellowish or golden-brown, longitudinal stripes on the back. The under parts are yellowish white, with alternating dark and light stripes on the hind legs. The *gopher frog*, unlike the pickerel and leopard frogs, has a hind leg to heel length shorter than the total length of the head and body and has its spotted dorsal skin also quite warty.

The *spadefoots* (Pl. IV, fig. 1),[a] with vertical pupils and sharp spades on their hind feet, are almost large enough to be of value in the market, but are uncertain in habits. The *toads* (Pl. IV, fig. 2), with parotoid glands just back of the eye and with warty skins, may some day serve as food, though a greater prejudice will have to be overcome than in the case of the frogs.

UNDESIRABLE SPECIES.

The tree frogs, with no parotoid gland back of the eye and with disks on the fingers and toes, comprise most of this class. The males of these creatures can always be told from true-frog males, because the area under the chin is always colored darker or differently from the rest of the under parts, while true frogs rarely have such a coloration. Rarely a male green frog or other species may have a yellow or another color under the chin, but it is not sharply indicated, as in the tree frogs, and does not appear discolored.

Common among these tree frogs are some with small disks and a length of 1 inch or less; namely the *cricket frog* (*Acris gryllus*) with a triangle between its eyes, webbed feet, and prominent, alternating, dark and light longitudinal bands on the back of the thighs; and the *swamp cricket frog* (Pseudacris) with webs small or absent and with a more or less smooth skin.

The tree frogs proper, with large disks, are several in number, of which the peeper, the tree toad, the Carolina tree frog, the Florida tree frog, the Pacific tree frog, and the southern tree frog are most common. None reach much beyond 2 or, at the most, 2½ inches in length. The brownish and smooth *peeper* (*Hyla crucifer*) (Pl. XXII, fig. 16), is recognized by an X-shaped mark on its back. The *tree toad* (*H. versicolor*) (Pl. XI, fig. 3) of the eastern United States is grayish brown or green; is rough of skin; and has a light spot below the eye and a network of dark and yellow on the posterior part of the thighs, while its relative of the southwest (*H. arenicolor*) has no network on the thighs. The tree toad of the piney woods (*H. femoralis*) has the posterior surface of the thighs, with round yellowish or white spots, but not a reticulation or network. The *Carolina tree frog* (*H. cinerea*) is grass-green above, with a straw-colored stripe along the side of the head and body, while *H. evittata* of Maryland and Virginia has no such stripe. The green of Anderson's tree

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[a] See footnote, p. 22.

toad (*H. andersonii*) is bounded beneath by a white line and this by a purplish brown or purple color. The *Florida tree frog* (*H. gratiosa*) of Florida and Georgia, the largest (2½ inches long) of all our tree frogs, has many roundish spots on its dorsal surfaces and very large disks. The *Pacific tree frog* (*Hyla regilla*) and the *southern tree frog* (*H. squirella*) have the thighs with no particular color pattern, are not pure green on the back, like the Carolina tree frog, and have the body not so slim as in this form. One occurs on the Pacific coast and the other in our southern States.

Our *narrow-mouthed toads*, unlike the true frogs, have no teeth in the upper jaw, are never 2 inches in length, have the eardrum hidden, and possess a peculiar fold of skin on the top of the head.

CULTURE OF FROGS.

BREEDING HABITS.

Those frogs which appear in the early spring usually begin croaking at once and proceed to pair and ovulate with little or no intervals between appearance and egg laying, while those which appear last wait for longer periods between emergence and croaking and between croaking and ovulation. It has been much in vogue to say of many species that they breed "in early spring," but many of our forms of which this has been said do not breed until summer. The males in many cases resort to the breeding grounds before the females, and the females may wait until their eggs are ripe before they enter the water. Or, as is the case with some toads, the two may meet on the trip to the water and become mated before the destination is reached. The croaking or mating male seizes the first female within reach and maintains his embrace until the eggs are laid. Sometimes in gregarious species six or eight males strive for one female, and often the female is killed. Fertilization comes exactly at the extrusion of the eggs or slightly after it.

At first no envelopes about the eggs are apparent and the egg mass may feel soft and sticky. After a few minutes this substance absorbs water, and each egg then is revealed to be a spherical body closely surrounded by a membrane and by one or two jellylike envelopes. (See fig. 1.) Some eggs have only the inner envelope present. This gelatinous substance comes from the oviduct and forms, when swollen, the egg capsules, tubes, bands, films, or masses to which we are so accustomed. The egg masses (Pls. XIII to XIX) are spherical in the wood frog, the pickerel frog, and in some of the other true frogs; plinthlike in the leopard frog and southern leopard frog; a spiral in the various toads; a surface film in the green frog, bullfrog, and tree toad; and a submerged film or mass in the swamp cricket frog. In the peeper and cricket frog the eggs are separate. The wood, pickerel, and leopard frogs lay their whole complement in a short time; the film form of the green frog, bullfrog, and tree frog takes longer, the first two maintaining the same position and the latter moving about during the process. With the toads and spadefoots some time is consumed in laying their spirals or bands. In the peeper several hours may transpire before the eggs are all laid.

DEVELOPMENT AND TRANSFORMATION.

The eggs hatch in from 3 or 4 to 25 days, depending on the temperature conditions. At hatching, the larvæ have a distinct neck, with a prominent head and body. The tail is very small or absent. On the ventral side of the head is an invagination or depression which is to be the mouth. Behind this comes the ventral adhesive disk or disks, which help the little creature to attach itself to the egg mass or to hang itself upon some plants. In front of the mouth are two deep, dark pits which later become the nostrils. On either side of the head appear swellings which become the external gills. The eyes do not yet appear.

As development goes on the external gills appear as branched organs, two or three on a side; the eye shows as a ring beneath the skin; and the tail grows and presents a middle muscular portion where the muscle segments clearly show. This middle part supports a thin, waferlike tail fin the parts of which are called, respectively, the lower and upper crests. The nasal pit shifts in position and becomes the nostril, and the vent opens. The mouth appears, and dependence on the yolk of the belly ceases. Soon the external gills begin to disappear, a lateral flap or fold of skin connects the head with the body, and the neck region disappears. Beneath this fold internal gills develop. On the left side, the lateral flap does not close completely, but leaves an opening, the spiracle. The water passes into the mouth over the internal gills and out this hole on the left side. On the mouth a membranous, fringed lip, with upper and lower portion, comes into being. At the portal are horny jaws or mandibles. On the upper and lower portions are rows of horny teeth. The eye is no longer a covered pigmented ring, but is now at the surface. The intestine has become much elongated and coiled. The buds of the hind limbs begin to appear. The fore limbs start to develop beneath the skin. When the hind limbs have reached considerable size the left arm comes out through the spiracle and the right arm breaks through the skin.

The process of transformation is now on. The tail crests decrease in size, and the creature begins to live on its tail; that is, absorbs it. The gills vanish, and the lungs begin to serve as the sole respiratory organs, if the skin be not considered. The eye assumes eyelids. The tadpole mouth fringe, with its horny jaws and horny teeth, is discarded, and a true frog mouth begins to appear. The long intestine becomes wonderfully shortened, and the small frog, with a vestige of a tail, is ready to leave the water. This process is termed transformation or metamorphosis.

SELECTION OF STOCK.

Most of the inquiries which the Bureau receives center about possible literature concerning frog culture or about the supply of breeding-frog stock, frogs either unmated or mated, eggs, or tadpoles. At the present time no supply bureau or hatchery can offer certified eggs or tadpoles of a particular species, and rarely can mated pairs be supplied. Some of the dealers in zoological supplies and some hatcheries can furnish frogs and might at certain seasons offer to furnish mated pairs. But such, which are paired in captivity, would

FIG. 1.—HABITAT OF THE LEOPARD FROG; A LARGE CAT-TAIL AND SEDGY SWAMP.

FIG. 2.—HABITAT OF THE PICKEREL FROG; THE BACKWATER OF AN UPLAND STREAM.

FIG. 1.—HABITAT OF THE GREEN FROG; A PERMANENT POND (FOREGROUND) NEAR A STREAM (BACKGROUND).

FIG. 2.—HABITAT OF THE BULLFROG; A MILL POND FILLED WITH STUMPS, FALLEN TREES, ETC.

usually be undesirable; they might lay in transit, break the embrace en route, or never lay at all, as is generally the rule. A more extended discussion of the five or six groups of stock follows: (1) Individual frogs; (2) mated pairs; (3) eggs; (4) tadpoles; and (5) transition stages.

INDIVIDUAL FROGS.

In many ways it might appear that the easiest and most certain method of securing stock would be to begin with the individual frogs. To be sure, they are to be found throughout the active period of the year—that is, from the early thaws of spring to the hard frosts of fall—but one must know their breeding season or he may carry them almost a year before the first eggs are secured. If the material come from a supply bureau, there is no certainty as to the period of previous captivity, the amount of freedom the frogs had in such quarters, etc. Frequently it has been found that with the leopard frog, green frog, and bullfrog the males were first captured and the females taken later, sometimes two or three weeks afterwards. To hold the males in captivity or in close quarters tends to reduce their breeding potentiality. Or, if females be captured just before breeding and be brought into the hatchery to await the subsequent capture of impulsive breeding males, the chances are that in rare cases the female may lay without the male, or that, by the time a pair or pairs are mated in the laboratory or hatchery, one or the other member may be weakened, and the pair may continue in the embrace several weeks until the death of one or both individuals. In most cases such a mated pair proves unfruitful. Over and over again has the writer taken gravid females and mated them with captive males or with males subsequently taken, and in almost every instance no eggs were laid or, if so, they were frequently infertile.

If, however, the experimenter has a good pond or water inclosure, with more or less natural conditions, he might stock it with individual frogs and not encounter the above difficulties so inherent in confining frogs in close quarters. If the prospective culturist wishes to start with the individual frogs, he must choose or determine what species he prefers or what his region offers. At present the four principal eastern species for the frog market are the leopard frog, the pickerel frog, the green frog, and the bullfrog.

If the leopard frog be chosen, the person who purposes to breed this species can usually secure enough frogs from the swampy marshlands (Pl. V, fig. 1), or backwaters and overflow ponds of streams in his own neighborhood. The leopard or spring frog appears from its hibernation in the muddy bottoms of our marshes and ponds when the streams have just freed themselves of ice and the lowlands are overflowing. When the temperature of the water reaches 41 to 50°, they may confidently be expected to appear in numbers.[a] From the middle of March to the middle of April is the period in which to expect them to appear for breeding. In early spring, whenever a low guttural croaking is heard in swampy stretches, it is that of the leopard frog. The croak is wholly unlike the shrill notes of the peeper and swamp cricket frog or the short

[a] The dates of first appearance, spawning, etc., of the commercial species were determined for the latitude of Ithaca, N. Y., but might well apply for northeastern United States if not for all of northern United States.

rattlelike note of the wood frog, all three of which are frogs too small to be considered commercially.

In the shallow water, along the edges of swamps, or on the banks of dead streams or backwaters one can find many leopard frogs. In the early spring—in fact, at all times during the breeding period—they can best be taken at night with an electric flashlight or acetylene lamp, lantern, or jack of any kind. Later in the spring the frogs are more easily captured during the day. To be sure that the captor has individuals of both sexes, he must be able to distinguish them. The male of a leopard frog has the thumb of the fore foot much enlarged on the inner edge and has a vocal sac between each ear and shoulder. These vocal sacs can be demonstrated by seizing the frog around the waist just in front of the hind limbs and alternately squeezing and relaxing the pressure. In this way a male will inflate the sacs. The ripe females are very gravid and swollen and have no vocal sacs and no enlarged thumbs. It seems advisable to have an equal, or preferably greater, number of males than females to insure all the females being mated. It seems to be the condition at the sexual congresses of this species that the males exceed the females in number. Of course there is some evidence that a male may mate the second time in a season, but this is not fully established. Frequently the author has put his captives in close quarters to obtain quick matings and then placed the pairs in the pond or inclosure meant for the breeding purposes. To keep them mated more than two or three days at the most in the laboratory or hatchery may result in a long embrace, and this defeats the purpose of the operation. If the culturist plans to begin with adult breeders, he can secure individuals of this species without great difficulty, because it is so gregarious at the time of the breeding assemblies; he will have a little more difficulty in locating the smaller gregarious breeder, the pickerel frog, and doubtless even a lesser measure of success in the case of the more solitary green frogs and bullfrogs.

It is yet a doubtful question whether the pickerel frog will become as important a commercial form as the leopard frog, green frog, or bullfrog. It is slightly smaller than the leopard frog, and the acrid secretion of its skin may militate against its availability. Whoever wishes to experiment with it will not find it in exactly the same habitat as the leopard frog. The leopard frog is essentially a frog (in its greatest abundance) of the cat-tail swamps, sedgy marshes (Pl. V, fig. 1), and grassy overflows (Pl. VII, fig. 1), while the pickerel frog is more often found in sphagnum bogs, marl ponds, cold streams, in the shallows of mill ponds, or in the quiet waters of bayous (Pl. V, fig. 2), away from the currents of our clear streams. It usually appears from hibernation about the same time as the toad and later than the leopard frog. When the air temperatures approach 48 to 58°, pickerel frogs begin to appear and become numerous at 58 to 67°. They hibernate in the water, and when it reaches 45 to 53° they come out of their winter sleep. In point of time this outcoming occurs between March 19 and April 25. The croak of the male is low and grating, and usually to the tyro this will be a poor guide for their capture. The male is usually smaller, darker in color, and with the thumbs enlarged, as in the males of the leopard frog.

FIG. 1.—HABITAT OF THE LEOPARD FROG AND TOAD; AN OVERFLOW AREA OF A STREAM. DRIES UP IN MIDSUMMER.

FIG. 2.—HABITAT OF THE TOAD AND PEEPER; A SHALLOW MEADOW POND WHICH DRIES UP IN MIDSUMMER.

FIG. 1.—HABITAT OF THE WOOD FROG; A WOODLAND POND.

FIG. 2.—HABITAT OF THE MINK FROG; A BEAVER POND FILLED WITH WATER LILIES, DORSET, ONTARIO.

The green frog is one of the solitary species. In habitat it is not as restricted as the bullfrog. Both occur in swamps, and in our deeper, larger ponds and reservoirs. In the smaller ponds and pools only the green frog is present. In fact, along watercourses there is hardly a small pond (Pl. VI, fig. 1) which can not claim a green frog. In the swamps only does the leopard frog exceed it in abundance. The latter often inhabits the less permanent situations; the green frog usually chooses more permanent, deeper bodies of water. The green frog starts to appear when the air reaches 54 to 61° and quite commonly at 61 to 69°. It also, like the leopard frog, pickerel frog, and bullfrog, hibernates in the water and awakens when the temperature of the water reaches 46 to 58°. It most assuredly is not "the first species heard in the spring." In fact, it does not begin to croak until a month after its first appearance. Then its low-pitched, short "bass-viol" note is very distinctive. The male of the green frog also has enlarged thumbs, and, in addition, has a yellow throat and a tympanum larger than the eye, while the female has a tympanum only equal in size to the eye. This species, being solitary, would be hard to secure alive in sufficient quantities for breeding purposes unless more effort were expended on its capture than it was actually worth. Wherever they are common, as in big mill ponds and small lakes, one might take enough to determine if the green frog be the species most desired. They are best taken at night.

Finally, in the East, the bullfrog appears to be the most desirable because of its size. One commonly associates the bullfrog with marshy bayous, buttonbush swamps, mill ponds (Pl. VI., fig. 2), or lakes. They are not, however, as restricted in habitat as some texts might lead the reader to infer. The author has found them along both upland and lowland streams, in clear brooks which fed cold, marly, sphagnum ponds, and along watercourses laden with such marshy vegetation as lizard's-tail, marsh cress, arrowhead, pickerel weed, and swamp loosestrife. Rarely they have appeared in small numbers in temporary or very small ponds, a more logical home for the green frog. Such distribution can ordinarily be explained by the loss or draining of a former mill pond or reservoir habitat near by, and such records are more accidental than normal. These frogs seem to prefer mill ponds, hydraulic lakes, reservoirs, and kindred bodies of water. The author's best collecting grounds were a clear, glacial lake in a New England kettle hole, with a slight suggestion of the sphagnous flora about it; a pond in a clear trout brook; a large reservoir for a hydraulic laboratory; a disused mill pond; and a wooded lake whose shifting water level had made a fringe of overhanging dead trees, floating logs, and submerged roots and limbs. In every case the shores were more or less wooded, but more important are two factors: Shallows where the species can transform; and brush, stumps whose roots are at the edge of the pond or overturned and driftwood along the banks.

When the bullfrog comes out, at least seven of the species which appear in the spring are entirely or almost finished with their spawning. The bullfrog is such a wary form that in some years its presence is not suspected until June, when croaking begins. When the air

reaches 68 to 75° (certainly 76 to 79°), the appearance of the bullfrogs may be expected, provided the temperature of the water bottoms is 57 to 64° or averages 64 to 69°. They are the last frogs to appear and come out from May 11 to June 4. They begin to croak about two or three weeks after emergence from hibernation.

When croaking begins, the males often take certain perches in which they keep a proprietary interest. About one pond the author once located seven such places, each with its possessor, only once finding two in one place. The characteristics of the stands can best be described by presenting the following list of positions occupied by certain frogs in one pond: The first was on a board in water filled with brush; another was perched on a log among brush beneath a float of a boathouse; the third was on the bank among some limbs extending into the water; the fourth was by an overturned stump whose roots were partly out of the water and partly submerged; the fifth was among some driftwood along the shore; the sixth was a stationary float; and the last was at the base of a tree fallen into the pond. At these stands one could have had good success in capturing the frogs at night. This habit of maintaining perches obtains more particularly when the species is not especially numerous in a pond or lake. When, however, the numbers of males about a lake are numerous enough to make their night croaking seem a real chorus, and when they are abundant among the fallen logs and brush of the swampy borders of lakes, it is not likely that any one individual holds a favorite site to the exclusion of the others. In such places one can easily take, in an hour or so, 30 or 40 adults with the aid of either flash light or acetylene light.

If one wishes to secure them by day he may adopt the device of the familiar red flannel on a hook or ordinary fish bait. At the breeding season one occasionally finds them in grassy situations. Here they lie on the surface of the water. One has only to wade among them to capture them by hand. At first they may become frightened, but soon they reappear. Whenever bullfrogs are hard to find or scarce in certain bad seasons let the collector search out a former mill pond whose dam is gone, and in the temporary small ponds remaining he can frequently find the frogs in their circumscribed quarters.

The males have the first finger enlarged (Pl. XII, fig. 4) and enlarged tympana. They begin croaking 15 to 30 days before actual spawning takes place. In some ponds the males are very much in evidence. In one lake, when the bullfrogs were laying freely, as many as 10 males were found within a space of 8 feet. Here among the dead branches of overhanging elderberry bushes (Pl. XIII, fig. 1) they were hidden because of the dense mat made by the shrubs. At this time in midday the author had no difficulty in capturing, by hand, in half an hour, some 25 males, while only three or four females were observed. This was in the middle of June. Later in the season the females appear more in evidence. Doubtless these easy captures of a supposedly shy form were naturally due to the fact that it was their breeding season. The author is, however, coming to believe that this species is as easy of capture as any other large frog. Even after a bullfrog has left the water's surface one may capture it while it is swimming beneath the water, for it is very slow as compared with some of the other

FIG. 1.—HABITAT OF COUCH'S AND HAMMOND'S SPADEFOOTS AND OF TWO TOADS (BUFO WOODHOUSII AND BUFO COMPACTILIS), SIERRA BLANCA, TEX.

FIG. 2.—HABITAT OF THE SOUTHERN BULLFROG; OVERFLOWED AREA AND TANGLED SWAMP OF A CLEAR SOUTHERN STREAM, THEODORE, ALA.

FIG. 1.—HABITAT OF THE CRICKET FROG; A SHALLOW GRASSY AND SEDGY MEADOW POOL, DINWIDDIE, VA.

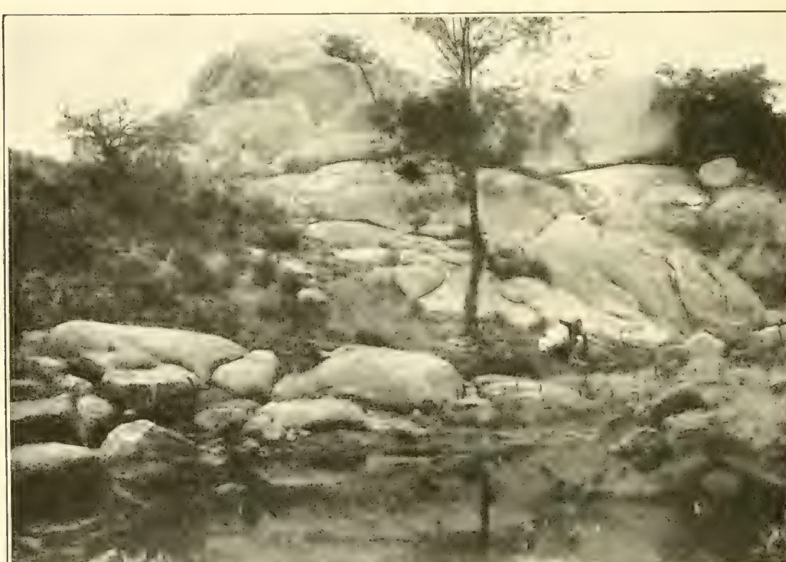

FIG. 2.—HABITAT OF THE DESERT TREE TOAD (HYLA ARENICOLOR) AND OF A TOAD (BUFO PUNCTATUS); A ROCKY CREEK IN A DESERT MOUNTAIN PASS, DRAGOON, TEXAS PASS, ARIZ.

forms. If one wish to stock his inclosure or ponds with adults, let him do it by the first of July, or preferably by June 1.

The southern bullfrog is one of the common forms of the deep-wooded swamps and of the water-lily-filled watercourses of such areas and is often called the swamp bullfrog. Equally frequent is it in the vast, open, swampy stretches or "prairies" of the Everglade, Okefinokee, and other famous southern swamps. The bright green and yellow of the under parts make it very conspicuous when in hand. Often these creatures will not dive until within an oar's length, but in the main this species is a shy form. Occasionally the author has taken them when visiting trap lanterns in aquatic situations.

The southern leopard frog is similar to the common leopard frog in habitat, mating, and general habits.

MATED PAIRS (PLS. XI AND XII).

Some articles on frog culture advocate stocking the suitable waters with a sufficient number of mated pairs of mature frogs. To the writer the main consideration in using individual breeders or mated pairs is that it positively proves to the beginner the identity of the species with which he is stocking his waters. Heretofore the most creditable published attempts with eggs or tadpoles taken afield leaves one with the impression that the experimenter was not absolutely sure whether he had good or worthless species. If mated pairs be the starting point, avoid pairs mated in captivity by some one other than yourself, for you do not know their period of captivity. If mated by the person concerned within one or two days after being taken in the field, return them to the out-of-door environment at once. The only sure source of fertile pairs is the field-mated pairs. The writer finds that in at least nine different species of frogs the pairs captured afield usually remain mated, no matter how long the journey to the laboratory or hatchery or pond, however roughly handled, or however hot the glass jar (not advisable) became from sun exposure. If they broke apart on the trip, they soon resumed mating and seldom released their hold when transferred from aquarium to aquarium or from pond to pond.

When mated pairs are secured in the field, one can reasonably expect them to lay the following night or the next day unless the temperature of the water drops suddenly. Rarely a pair may wait several days before ovulation. The prospective frog breeder can identify his material by the mode of embrace. All of the four principal commercial eastern frogs belong to the true-frog (Rana) group, in which the male holds the female behind the forearm with his hands appressed to the breast of the female (Pl. XI, figs. 1 and 2). This is the so-called pectoral embrace, and any mated pair with pectoral embrace found after April 25 is almost positively one of the four principal marketable eastern species. Before April 25 the wood frog pairs might be taken; but if the characters of this species already described are remembered, no mistake will be made.

Desirable species.—Of the four principal marketable eastern species, the mating of the leopard frog is easily the most familiar. This species is not restricted to night courtship, although most of it occurs at this time, and more mated pairs can be secured at night with

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a light than in the daytime. One can frequently observe the mating behavior of this species during the day, if he can discover a spot where the species has already begun ovulation. The author has taken most of his mated pairs under such conditions. Before they are mated the males may be heard croaking at the surface. Occasionally when wading through an area in which eggs are numerous, one hears croaks which at first puzzle him; they come from the mated and mating frogs beneath the water and often reveal the position of the game on the bottom. At such times, one finds several males and gravid females about and under sticks. More rarely, the pairs appear at the surface. The period of mating begins April 1 or before, but the bulk of it does not come until the middle of April; it continues for about three weeks, extending to the first or middle of May.

Like the leopard frog, the pickerel frog is gregarious at the breeding time and often gathers in small, restricted areas for egg laying. This facilitates its capture. The beginning of mating usually comes the last week in April, the earliest record being April 5, the average April 23. This species mates by day or night. The author has seen very vigorous matings at all times of day. Often, within a small area 6 feet square or less, one can find 12 to 15 pickerel frogs mating or pairs in egg-laying positions. The mating places are often, but not always, in shallows. Along one shore, within a short stretch, the author has counted 20 or more frogs actively mating, to say nothing of those in the water. In one instance, in a space 3 feet square, were 21 unmated males, 5 mated pairs, and 8 fresh egg masses (representing 16 more frogs). Usually with most of the frogs, mated pairs, captured in the field, laid the night of the same day of their capture, but the rule did not always hold true with the pickerel frog; in fact, it seemed the exception. To find pairs of pickerel frogs which had mated in the laboratory waiting two or three days before ovulation was not surprising, but frequently pairs from the field waited from two to five days before laying. In two instances in different years (one, in an early season, the other in a late season) the eggs were laid after remaining in the embrace a week. In 1912 a pair continued in the embrace two weeks before ovulation. This delayed deposition makes the pickerel frog less desirable than the leopard frog.

The green frog is a solitary species. This habit makes it difficult to capture mated pairs in the field. One might better begin with the eggs or tadpoles or adult breeders. The mating is more active at night than by day. It does not begin before the latter part of May. With captive individuals it has been noted as early as May 22. The interval between first croaking and actual mating may be considerable. In his night collecting the author not infrequently located places where a male might be found croaking several nights in succession. Egg masses have subsequently been recorded in such spots so often that it has been found a good plan to keep such localities in mind when searching for eggs by day or night. About such masses the original or other males are afterwards frequently found for varying periods. In fact, many have been captured in this way.

The bullfrog is as shy as the green frog, and only about places where they are abundant could one ever hope to capture an appreciable number of pairs.

FIG. 1.—GREEN FROGS. EARDRUM NORMAL IN FEMALE, ENLARGED IN MALE.
(After Wright, Carnegie Publ. No. 197.)

FIG. 2.—LEOPARD FROGS. PECTORAL EMBRACE.
(After Wright, Carnegie Publ. No. 197.)

FIG. 3.—TREE TOADS. AXILLARY EMBRACE.
(After Wright, Carnegie Publ. No. 197.)

FIG. 4.—COUCH'S SPADEFOOTS. INGUINAL EMBRACE.

FIG. 1.—WOOD FROG. CONCAVE WEB OF FEMALE.

FIG. 2.—WOOD FROG. CONVEX WEB OF MALE.

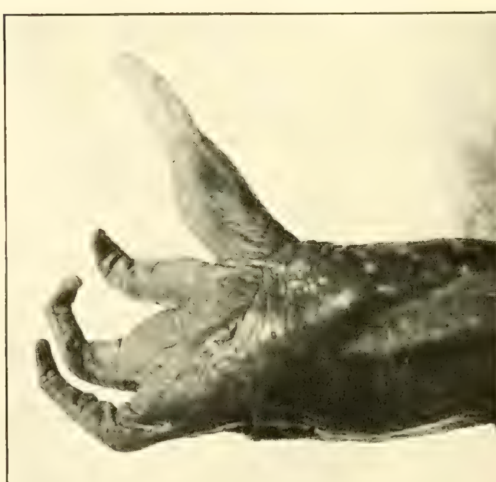


FIG. 3.—BULLFROG. FOREFINGER OF FEMALE NOT SWOLLEN.

FIG. 4.—BULLFROG. FOREFINGER OF MALE VERY MUCH SWOLLEN.

The author found the southern bullfrog at the breeding season in the swampy tangles of buttonbushes and white alders, where the water was waist deep and the bushes 8 to 12 feet high. In southern Alabama he recorded croaking males as not uncommon in overflowed areas and swamps (Pl. IX, fig. 2) of clear streams, especially if overgrown with a thick mat of cat briars (smilax) and arrow arums. In the main their croakings consist of four or five notes and are wholly unlike the call of the northern bullfrog. To some people there is something of the human voice in their call; to others it sounds like an alligator. If the ventriloquial males be in tangles they are hard to discover. These croaking males may also occur along the deep-wooded, overflowed banks of southern rivers. The males have the eardrums enlarged (see green frog, Pl. XI, fig. 1) and the first finger swollen. (See bullfrog, Pl. XII, fig. 4.)

Possible Species.—At all seasons, except the breeding time, the wood frog is silent and retiring. In water at the spring congress they are difficult of approach. At ordinary approach the best one can hope for is only a series of surface ripples. Such assemblies may not last more than a day or so each year. Anywhere from 50 to 200 males have thus been observed floating at the surface. The scene resembles a small toad assembly, in which there is the same scrabbling and zeal of mating. They disappear simultaneously on seeing anyone, and on going through the pond a minute later one would wonder where the 200 males could be, to say nothing of the females. At the approach of the breeding season the males have the thumb much swollen and the webbing in the hind feet with margin convex, not concave, as in the females at all seasons and in males at other seasons of the year (Pl. XII, figs. 1 and 2). The period of mating has begun in some years as early as the middle of March and may rarely extend to May 1. The species is customarily at the height of sexual ardor the last week of March or the first week in April. They mate to some extent by day, but more frequently during the night.

In the common toad the males are noticeably smaller than the females, have dark throats, and at the breeding season possess dark-brown excrescences on the inner upper side of the first two fingers (rarely on the inner edge of third finger) and on the inner carpal tubercle. Both sexes repair to the water about the same time. The migrations begin early in April, but the toads have been recorded migrating to breeding localities as late as June 14, by which date many of the early breeders are leaving or have left the ponds.

The males far outnumber the females, and the furious actions incident to the first meetings of the two sexes, or following the arrivals of other toads, are long sustained and exhausting. The male embraces the female by digging its forearms into the axilla of the female, the fore fingers of the male being folded up. (See tree toad, Pl. XI, fig. 3). In this way it is clearly seen how the dorsal horny excrescences of the first three fingers of the male come into use.

In the west and southwest six species of toads may continue to breed as late as July or August, dependent on the rains, and in each species the male has the same kind of excrescences on the fingers and the same form of embrace as already described for the common toad. Because of their greater size two of these six might be of more commercial importance than our common toad. They are *Bufo woodhousii* and *B. alvarius*.

The hermit spadefoot toad [a] appears suddenly after prolonged rains in April and May or sometimes June or July. At the breeding season it is fond of sprawling out on the surface of the water as a wood frog does; and it is from this position that it croaks. This species gathers in large breeding assemblies like toads, and the matings are as spirited. The male seizes the female just ahead of the hind legs (inguinal fashion), a form of embrace not known in any other American forms except in the narrow-mouthed toads and possibly *Ascaphus truei* of Washington.

The same form of embrace (Pl. XI, fig. 4) and dependence on rains seems to hold true of Couch's and Hammond's spadefoots of the southwest and west, where the writer has observed their breeding habits. In these regions, after long droughts, these creatures and other species of toads at night almost literally pour down from the mountains or in the desert to any temporary streams (Pl. IX, fig. 1), pools, or "tanks," and their strange choruses can sometimes be heard from one-half to a mile away. The croaks of the Couch's spadefoot are given from the edges of swift-flowing, temporary streams or ponds and resemble the mewing of a cat. The males of Hammond's spadefoot float more or less on the surface of the water and, like the hermit spadefoot, dip the posterior portion of the body as they croak. Sometimes when both species are breeding in the same place at the same time cross embraces between the species ensue.

Undesirable Species.—In the undesirable species such as tree frogs, like the peeper and tree toad (Hyla), the cricket frog (Acris), and the swamp cricket frog (Pseudacris), the mating embrace is axillary (Pl. XI, fig. 3), and any mated pair with such a form of embrace is an undesirable species, unless it be the possible form, the toad. The narrow-mouthed toads (Gastrophryne) have the inguinal form (Pl. XI, fig. 4) of embrace, and no desirable form normally mates in this way. The possible form, the hermit spadefoot (Scaphiopus) does mate in this manner, and sometimes a weakened male toad (Bufo) with normal axillary embrace or a weakened male frog (Rana) with normal pectoral embrace may seize a female just ahead of the hind legs (inguinal fashion) in lieu of the normal embrace.

EGGS.

Several experimenters have suggested that to rear frogs for the market one could best start with eggs easily procured in nature. This apparent ease, however, has often led people to work with undesirable stock; and even some of the experimenters themselves have not been absolutely sure to which species of frogs the eggs belonged. With certain precautions as to the identity of the material, it is a convenient point at which to begin the work. It is, however, highly essential that one know the undesirable frogs and their eggs—the tree frogs, swamp cricket frog, peeper, cricket frog, and the large tree frogs; the narrow-mouthed toad; and the oak toad; and also the possible forms—the wood frog, other smaller frogs, the toad, and the spadefoot.

Desirable Species.—In the early spring the leopard frog is the second true frog to begin ovulation. It prefers cat-tail swamps

[a] Overton, Frank: Long Island fauna and flora. The frogs and toads. Museum, Brooklyn Institute of Arts and Sciences. Science Bulletin, vol. 2, No. 3, pp. 28-30. The author wishes to thank Dr. Overton and the Brooklyn Museum for the generous loan of Pl. IV, fig. 1, and Pl. XVIII, fig. 4.

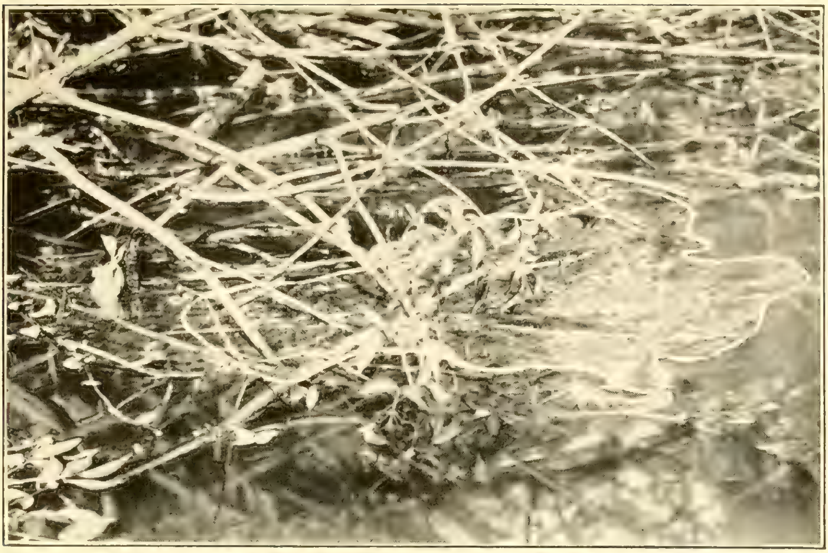


FIG. 1.—A SURFACE FILM OF BULLFROG EGGS ATTACHED TO THE TIPS OF ELDERBERRY BUSHES.

FIG. 2.—AN EGG AREA OF LEOPARD-FROG EGGS, THE EGG MASSES ON THE BOTTOM OR ATTACHED TO VEGETATION.

(After Wright, Carnegie Publ. No. 197.)

FIG. 3.—A SURFACE FILM OF GREEN-FROG EGGS AMONG VEGETATION.

(After Wright, Carnegie Publ. No. 197.)

(Pl. V, fig. 1), marshy expanses of other types, grassy overflows (Pl. VII, fig. 1), and shallow, dead streams. In other situations than these it breeds sparingly. In some places it begins laying before April 1, and the period of ovulation may extend to May 15. In general, when the air temperature reaches 43 to 48°, and certainly when it averages 51 to 55°, the leopard frog begins spawning. The temperature of the water varies from 43 to 45° at the beginning of breeding to 50 to 65° at its crest. The leopard frog may lay at any time of day, even at noon, but more frequently it spawns at night. Leopard frogs have a tendency to congregate in large numbers and often 40 or more bunches of eggs are recorded within small circumscribed areas (Pl. XIII, fig. 2). At such times, when an area is approached, the mated pairs often seek cover under the bunches which have already been laid.

The egg masses of the leopard frog may be attached to submerged cat-tails, twigs, sticks, grass, etc., or as often may rest on the bottom unattached. Several times the water's surface has been observed to be so low that the tops of the bunches appeared at the surface. The bunches of eggs occur in the open, unprotected, marshy expanses, or in overflows where the edges and bottoms have plenty of grass. One will often find the egg masses interspersed with algæ and dead leaves, which so fill the shallows that the bottom can not be seen. As a rule, the leopard frog tends to seek shallower water and more swampy localities than the wood frog. The egg mass at ovulation is 1 or 2 inches in diameter. After it has expanded it is plinthlike or flat, the greater diameter varying from 3 to 6 inches, the smaller from 2 to 3 inches (Pl. XIV, fig. 2). The eggs of this species might be confused with those of the wood frog, which lays during the same period. The differences between the two are elaborated under the wood frog (p. 28). Under normal field conditions the eggs hatch in from 13 to 20 days.

The southern leopard frog, as well as the northern leopard frog, breeds normally in the spring, and hence is called the "spring frog," but occasionally its breeding period may extend until July 4, or later, after the first eggs of the species are hatched and the tadpoles transformed.

The egg mass of the southern leopard frog is plinthlike (Pl. XVIII, fig. 2), and the individual eggs are hardly distinguishable from those of the northern form. These masses may occur attached to vegetation along the quiet side shallows of streams or unattached upon the bottoms of pools, or they may be laid in swampy situations.

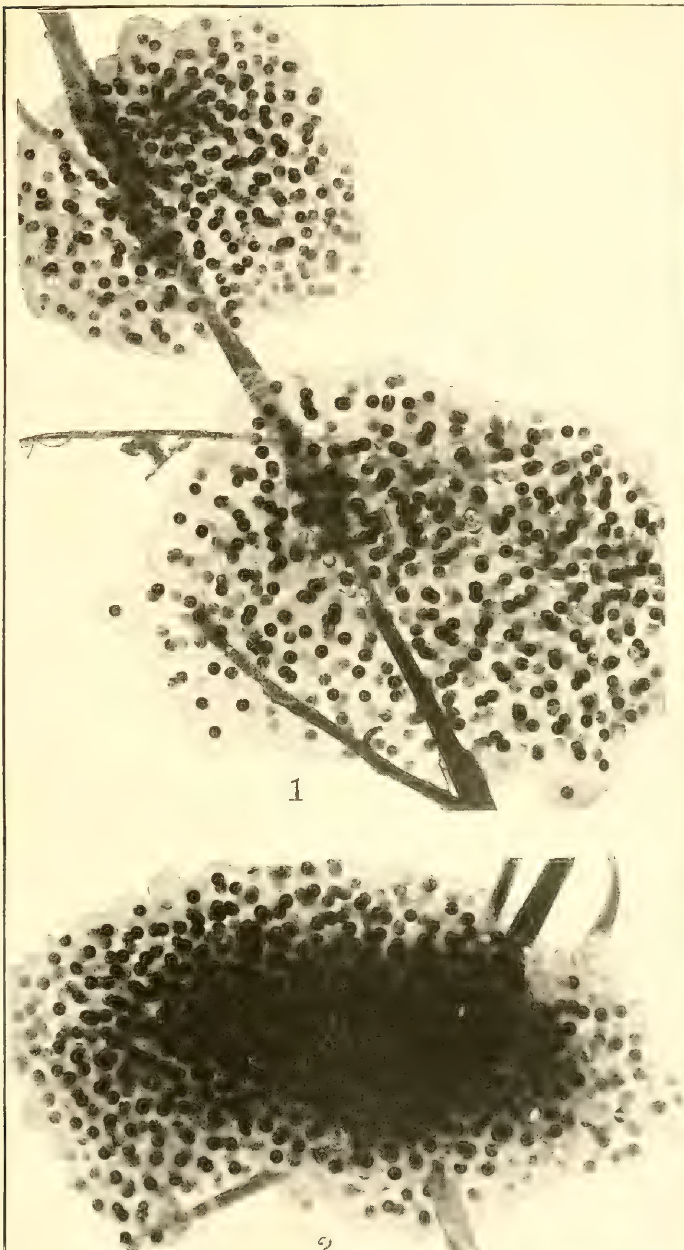
The pickerel frog, as far as the recorded situations show, seeks clear water, and, in the main, is usually found in the upper stretches of our clear streams. It frequents ponds heavily laden with dead leaves of quiet backwaters (Pl. V, fig. 2). The eggs are frequently found in the shallows of mill ponds, rocky holes of ravines, or lowland pools of wide, meandering streams. The bulk of egg laying occurs during the last week in April and the first week of May. Usually the period extends from April 23 to May 15. One may expect this species to begin laying when the temperature of the air reaches 50 to 61° and most certainly when 65 to 69° are recorded, provided the temperature of the water is 51 to 64°.

The eggs of the pickerel frog are almost invariably submerged and attached to sticks, twigs, or tufts of grass stems. The species

usually seeks the shallows for egg laying, although not exclusively. Almost every year some egg masses are found in the middle of ponds where the water is 3 feet deep or more. It tends to lay in special areas (Pl. XVII, fig. 3), as do the wood frog and the leopard frog. At one time, in an area 3 by 3 feet, 18 bunches were deposited. In another spot of the same dimensions 31 bunches were found. All of these areas gave excellent illustrations of the placing of bunches one upon another. The greatest number of bunches observed upon one support was a case in which 7 were noted. Quite frequently on one tuft of grass, or on a stick, one finds one or more bunches of eggs of the spotted salamander, a bunch of leopard frogs' eggs, and as many as two bunches of pickerel frogs' eggs immediately above them—seldom below, because laid later. At the time of deposition a bunch may be 1 to 2 inches in diameter, but it soon expands to $3\frac{1}{2}$ or 4 inches. It is usually firm and globular (Pl. XV, fig. 3). The egg complement of the pickerel frog may be from 2,000 to 3,000. The bright yellow or orange lower and the brown upper halves of the eggs of the pickerel frog make them the most easily distinguishable of all our true frogs' eggs. In nature the eggs may hatch within 11 to 21 days.

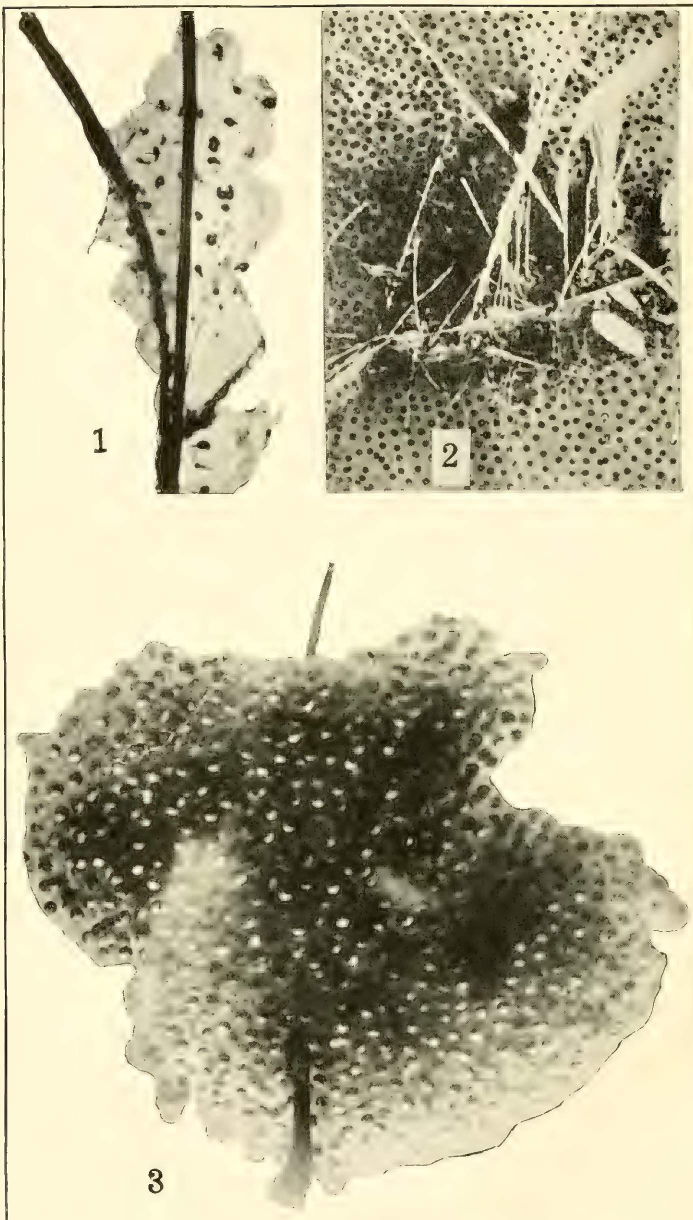
The green frog begins ovulation in the late spring or early summer, the extreme dates being May 23 and August 10. When the air temperature reaches 65 to 74°, or the temperature of the water surfaces 68 to 76°, the green frog may be expected to begin breeding. Surface temperatures are probably very influential in controlling the breeding habit, because of the position of the eggs after they are laid. When the air temperature reaches 80°, the species breeds commonly. During June and the first part of July the eggs of this form are very common; thereafter they diminish in numbers until the last of July or the first of August, when a few stragglers deposit the last eggs of the breeding season. This species lays mainly at night, but the author has twice seen it laying during the day.

The mass of the green frogs' eggs floats on the surface of the water. The typical form (Pl. XV, fig. 2) is a disklike film of a single layer of eggs, loosely attached or free. The eggs have the upper halves black and the lower halves white or creamy white. They may be found in the middle of the pond, where it is filled with a cover of algæ at the surface, or with hornwort, water milfoil, Chara, Nitella, or similar water plants, which make a mat of vegetation from the bottom to the surface, or where isolated patches of grass, water plantain, etc., grow in the middle of a pond. Usually, without such conditions, the masses occur about the edges of the pond (Pl. XIII, fig. 3), attached to grass, smartweed, etc., either growing in or extending into the water. In 100 or more cases hardly an exception to the surface deposition has been noted, but a few apparent exceptions have occurred. One egg complement was found in a somewhat scattered mass on leaves and twigs partially submerged. In another instance some of the complement was at the surface and the rest in water 4 to 6 inches deep. Inasmuch as such masses were found some time after deposition, a rise in the level of the pond could easily have brought about this anomalous condition. Another variation in the location of the egg mass is occasionally recorded. The mass may be attached to grass stems, the point of



FIGS. 1 AND 2.—FORM OF EGG MASSES.

1, Egg masses of wood frog, both masses globular; 2, egg mass of the leopard frog, mass plinthlike, not globular. (After Wright, Carnegie Publ. No. 197.)



FIGS. 1 TO 3.—FORM OF EGG MASSES.

1, Egg mass of the swamp cricket frog, several such bunches laid by one female; 2, egg mass of green frog, a surface film among vegetation; 3, egg masses of the pickerel frog, globular mass, frequently in tiers. (After Wright, Carnegie Publ. No. 197.)

attachment being some 4 or 5 inches below the surface of the water. This attachment serves as the apex of an inverted cone, and the base of the cone spreads out on the surface of the water. This also may be due to a rise in the level of the water. Rarely a mass more than a foot square is recorded. Some of these masses may be composite. In a certain pond, where numerous frogs had laid, two bunches had been placed so close together as to make a film 15 by 10 inches. In another case a mass just as large was secured, and the evidences of its double nature were even more evident than in the preceding instance.

For several years small isolated packets of eggs were found on the water's surface, distributed in the manner of tree toads' eggs, but without their individual characteristics. They could not have been those of the swamp cricket frogs' eggs, for this species lays very early in the spring. At last it was discovered that, as egg development went on, the egg masses of the green frog often lost their circular disklike form, assumed irregular shapes, and separated into small masses of 25 or more eggs, a natural process due to the jelly becoming loose as hatching approached. But the egg packets observed were composed of fresh eggs. In those instances the wind or strong currents, or both, caused them to float away from the original mass.

The bullfrog begins egg laying at air temperatures of 71 to 72°, or at water temperatures of 66 to 71°. On the average, however, breeding comes at an air temperature of 80° and at a water temperature of 70 to 71°. The bullfrog lays the last of June or in July. The author's breeding record for this frog extends from June 16 to July 10. Doubtless it begins earlier some years or extends beyond July 10 in belated seasons. The writer has taken females with ripe ova the last of July. Ovulation usually occurs at night, at which time the species is most active. The bullfrog is a solitary form, yet at the height of breeding a mill pond (Pl. VI, fig 2) may have a dozen or more pairs in it, and some lakes may be well enough supplied with them to furnish the famed bullfrog choruses of June and July.

Usually the egg masses of the bullfrog are found among brush or under similar cover (Pl. XVI, fig. 1). The disk form so prevalent in the egg masses of the green frog obtains with this species as well. In one instance the egg mass covered a space of 2 by 2½ feet, or 5 square feet; in a second case, 2 by 2 feet; and in a third, 2 by 1½ feet. The size of these masses is a sufficient criterion for identification, since it is very unusual to find an egg mass of the green frog which covers a square foot. The first of these three egg films was deposited upon a mass of driftwood and brush, which was at the surface; the second was found among some fresh white branches that extended into the water from the edge of the pond. In rare cases the masses become stringlike, due to shifting water levels. One such mass was found attached to the roots of an overturned stump in shallow water and another in brush beneath a boathouse float. Sometimes bullfrogs lay their films in midpond around stumps, or attach the surface egg film to the tips of overhanging bushes which extend into the water (Pl. XIII, fig. 1). The winds often break these films into pieces and distribute them along the shores of the lake or pond. The mass is glutinous and is not firm

and hard, as in the wood-frog, leopard-frog, and pickerel-frog eggs, which are laid earlier in the season. In the last of June and through July only one other common frog is breeding; namely, the green frog. The green frogs usually deposit their eggs upon vegetation. They lay on or among grass, water plants, and algæ, or along grassy edges of ponds, while the bullfrog almost invariably lays in brush. The egg complements of the two species are also different in size. The green frog seldom lays more than 3,500 or 4,000 eggs, while the bullfrog may lay from 10,000 to 20,000. Usually, the egg of the bullfrog has not the distinct middle envelope of jelly which is found in the green frog's egg (fig. 1, *F* and *D*). Furthermore, this middle envelope in the eggs of the green frog often is elliptical, and not round, as in the eggs of the leopard and pickerel frogs (fig. 1, *G* and *B*). In nature, the eggs hatch in four days or less.

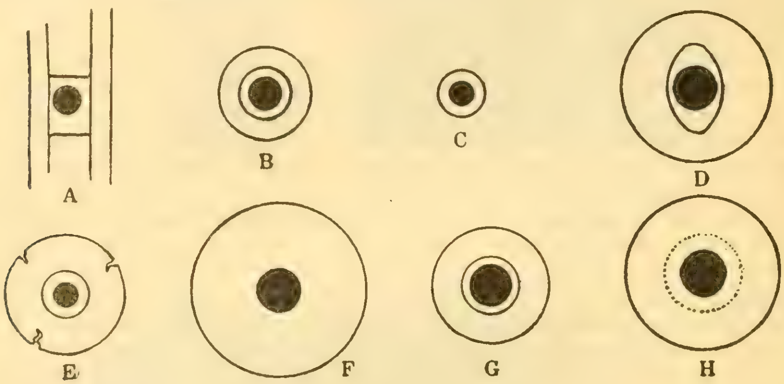


FIG. 1.—INDIVIDUAL EGGS (three times natural size).

A. Egg of common toad in two jelly envelopes or tubes, the inner of which is divided by cross partitions. *B*. Egg of pickerel frog. Inner envelope and egg proper of same size as egg of leopard frog (*G*) but outer envelope smaller. *C*. Egg of peeper. The one envelope and the egg proper together appear the duplicate of the egg of the tree toad (*E*) when it is stripped of its outer envelope. *D*. Egg of green frog. Unlike the egg of the bullfrog, it has an inner envelope. *E*. Egg of tree toad. The outer envelope often ragged in outline. *F*. Egg of bullfrog. Unlike the other four frogs, it has no inner envelope. *G*. Egg of leopard frog. Egg proper black and white, not brown and orange as in pickeral frog (*B*). *H*. Egg of wood frog. It has the largest egg proper of these eight species and larger envelopes than the confusing pickerel-frog (*B*) and leopard-frog (*G*) eggs. (After Wright, Carnegie publication No. 197.)

The eggs of the southern bullfrog are not known, and we are not very familiar with its breeding habits. In Georgia, Florida, and Alabama the writer has chanced upon this species in full croaking season in June and July. This species is reputed to lay small eggs in large masses on or at the surface of the water in the early summer, and if this be true the habits of this form are closely similar to those of the northern bullfrog.

POSSIBLE SPECIES.—The hermit spadefoot toad is one of the most erratic and transient of our toads or frogs. It suddenly appears after a shower, and egg laying is soon over after an ear-splitting chorus of croaking lasting a few days. Breeding usually occurs in April but occasionally persists until August. This species breeds in quiet pools and ponds (Pl. VII, fig. 2). The eggs are enveloped in a gelatinous band (Pl. XVIII, fig. 4), the cross section of which includes several eggs. In the common toads the eggs occur in one

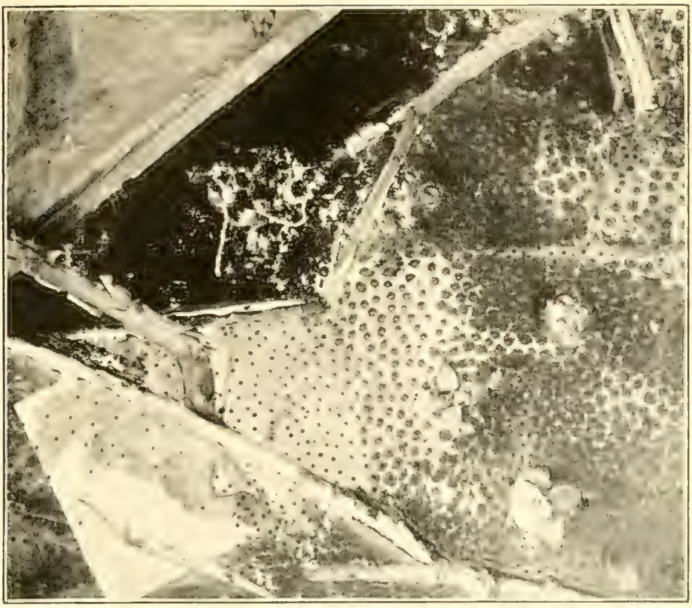


FIG. 1.—EGG MASS OF BULLFROG; A SURFACE FILM 18 INCHES IN DIAMETER LAID AMONG DEAD STICKS AND OLD BOARDS.

(After Wright, Carnegie Publ. No. 197.)

FIG. 2.—A SURFACE PACKET OF TREE-TOAD EGGS ATTACHED TO A POND-WEED LEAF.

(After Wright, Carnegie Publ. No. 197.)

FIG. 1.—COMMON TOAD EGG STRINGS CURLED ABOUT VEGETATION.
(After Wright, Carnegie Publ. No. 197.)

FIG. 2.—THE STALKED EGGS OF THE DESERT TREE TOAD (').

FIG. 3.—AN EGG AREA OF THE PICKEREL FROG AND TWO MATED PAIRS; EGG MASSES ATTACHED TO VEGETATION AND STICKS ON THE BOTTOM.

(After Wright, Carnegie Publ. No. 197.)

or two lines or files within one jelly tube. The eggs of the spadefoot usually hatch in a very short period.

While the hermit spadefoot lays eggs in bands like the European forms of this family, the spadefoots of the Southwest—namely, Couch's and Hammond's spadefoots—may strew them on the bottom of the ponds. These eggs may be singly placed or be in more or less agglutinated masses usually one egg deep and may be laid as late as mid-August. This peculiar arrangement of the egg complements may be due to the absence of suitable vegetation, since Strecker[a] has seen Couch's spadefoots lay egg bands which became attached to grass, etc.

The life histories of several smaller true frogs are unknown. These, including Cope's frog, the yellow-legged frog, and *Rana onca*, are too small to be considered.

The wood frog usually chooses still water for spawning, rarely backwaters or bayous of streams. It prefers the leaf-laden ponds (Pl. VIII, fig. 1) and transient pools of wooded districts, though not wholly restricted to such localities. Occasionally the author has seen the frogs migrating to swampy cat-tail stretches for spawning and has both observed and heard them in such situations. Two of his best collecting spots were a grassy pool and a high upland pond, both of which were out in the open and ordinarily dried up in midsummer. In wooded districts he has found them even using pools no more than 1½ by 4 feet in area. When the air temperatures average 53 to 58°, one may go out with some expectation of finding the wood frogs spawning, provided the water temperature is at least 41 to 48°. Spawning reaches its height usually at about 53 to 60°. The average date of spawning is about April 4; the author's earliest record is March 19; his latest first record, April 14. In general, wood frogs spawn most frequently in the first half of April, though occasionally earlier or later, depending on the season. In some years, when spring opens early, as the last of March, the spawning begins with a rush, and the species may be practically through laying within from four to six days after the beginning of ovulation. Most of the egg complements are laid at night, yet the author has frequent instances in which the eggs were laid during the day, both in the laboratory and in the field. In the laboratory, they have been observed to lay throughout the day; in the field, there have been numerous indications that eggs were laid during the day. This species is gregarious at the breeding season. Where the first bunch of eggs of the season is laid, one is quite certain to find other wood frogs depositing their complements later. In this way the whole egg content of a large pond may frequently be massed in a small limited area (Pl. XVIII, fig. 3).

The eggs of the wood frog may be deposited either near the edges or in the middle of the pond. They are usually attached to grass stems, weed stalks, twigs, or brush; but, in rare cases, they may rest free on the bottom. In this species the egg bunches tend to be attached more frequently than in the case of the leopard frog. In rare cases, wood-frog and leopard-frog masses are found on the same twig. The egg mass, at the time of laying, may be an inch in diameter. Within one-half hour to two hours it assumes a diameter

[a] Strecker, J. L.: Notes on the life history of *Scaphiopus couchii* Baird. Proceedings, Biological Society of Washington, Vol. XXI, p. 203. Washington, 1908.

of 2 or 3 inches. Freshly laid masses are always of a very bluish tinge. The eggs are usually found in shallow water, 6 inches to 2 or 3 feet deep, though occasionally eggs have been in water of a greater depth. The eggs of the wood frog are to be confused only with those of the leopard frog. In the former, the egg mass is globose (Pl. XIV, fig. 1); in the latter it is plinthlike. In the leopard-frog egg, the middle envelope is evident to the naked eye, which is not true of the wood-frog egg (fig. 1, *G* and *H*). The eggs of the wood frog are free, and the outer envelope of each egg keeps its spherical form more exactly than in the case of the leopard frog, where the eggs are closer together and both they and the outer envelopes smaller. The eggs of the wood frog are 3.6 to 5.5 mm. from each other, while in the leopard frog the eggs are 2.6 to 3.6 mm. apart. The two egg masses can be separated easily in the field by inverting the mass, thus revealing the lower side of each egg. In the eggs of the leopard frog the whiteness of the egg mass becomes very apparent, but in those of the wood frog the general effect is not decidedly that of whiteness, because of the evident encroachment of the black of the upper half upon the lower side.

The northern wood frog doubtless has breeding habits similar to those of the eastern wood frog.

The life history of the common toad will serve well enough as an example of the life histories of our more common toads. At the spawning season hundreds of pairs may be recorded laying at one time; and in one instance 10 pairs were secured within an area 1½ feet square. Any water hole, ditch, or transient pool may contain one or more toads at this season. They seemingly prefer the shallower waters and are apparently not particular whether it be grassy (Pl. VII, fig. 2), weedy, or swampy (Pl. VII, fig. 1), or whether the bottom be free or covered with fresh or dead vegetation. So long as water is at hand, their main desideratum is met. In choice of a breeding spot, then, the toad is easily suited and will use a greater variety of localities than any other anuran. This species may begin spawning when the temperature of the air is 50 to 51°, but the crest of the breeding season is reached at about 70°. Spawning may begin when the water temperature is as low as 51° but reaches a maximum when the water temperature is about 56 to 66°. The toad begins ovulation about April 23, the earliest examples recorded being April 5. The crest of ovulation comes about April 30. Thereafter the number of spawning pairs diminishes. By May 15 or 20 the bulk of the laying is about completed, and by May 20 or 25 nearly all the toads' eggs are hatched. In June there are a few stragglers. In rare instances the species lays through July. So, spawning in this species occasionally extends far beyond the transformation time of the first-hatched toad tadpoles of the season. Egg laying takes place both by day and by night. The female toad lays from 4,000 to 7,000 eggs. The eggs are laid ordinarily in quiet water; it may be shallow, but not always so. The eggs are found in pools and ponds, artificial or natural, in marshes, backwaters, ditches, etc. The strings may rest merely on the bottom or be twined about vegetation or sticks which happen to be near at hand (Pl. XVII, fig. 1). The eggs are laid in long, spiral tubes of jelly (Pl. XIX, fig. 2). Each egg, with its quadrangular envelope, is incased in two tubes of jelly, one tube within the other. (See fig. 1, *A*.) The hatching period is

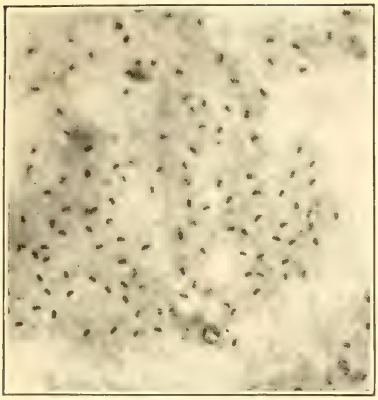


FIG. 1.—A SURFACE FILM OF TREE-TOAD EGGS.

FIG. 2.—A PLINTHLIKE EGG MASS OF THE SOUTHERN LEOPARD FROG.

FIG. 3.—AN EGG AREA OF THE WOOD FROG, THE EGG MASSES ATTACHED TO STICKS.

(After Wright, Carnegie Publ. No. 197.)

FIG. 4.—AN EGG BAND OF THE SPADEFOOT ATTACHED TO VEGETATION.

(After Overton. Mus. Brooklyn Inst. Arts & Sci. Sci. Bull., Vol. 2, No. 3.)

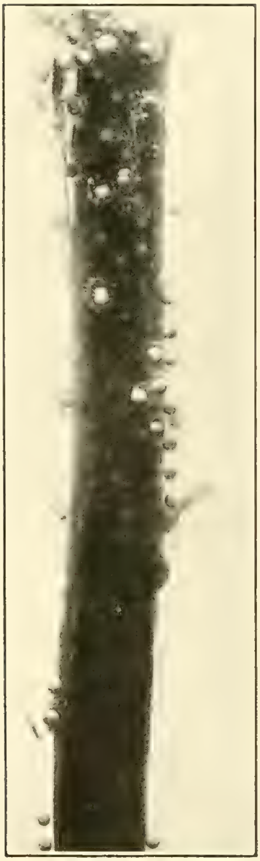


FIG. 1.—EGGS OF PEEPERS LAID IN THE AQUARIUM.

(After Wright, Carnegie Publ. No. 197.)

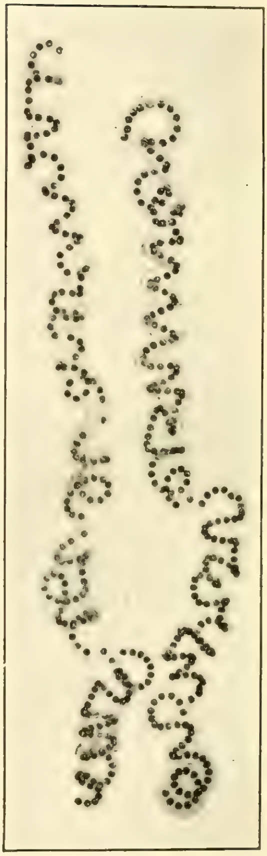


FIG. 2.—TWO EGG STRINGS OF THE TOAD; A STRING FROM EACH OVIDUCT.

(After Wright, Carnegie Publ. No. 197.)

very short. In general the eggs hatch within from three to five days. In colder seasons, the eggs may not hatch until 8 to 12 days have passed.

UNDESIRABLE SPECIES.—The swamp cricket frog, one of the first to appear in the spring, lays small bunches of eggs attached to sticks, leaf stems (Pl. XV, fig. 1), etc., in every transient pool, pond, or ditch, as well as in the swamps. In each bunch are 20 to 100 eggs. Usually the bunches are beneath the surface, but the mass is seldom over 1 to 1½ inches in diameter. The eggs, however, are black on the upper half and white on the lower half. Besides, the largest individual eggs of this species may be as large as the smallest green frog or bullfrog eggs, which, however, are not laid until summer. Furthermore, the smallness of the mass enables one to distinguish the swamp cricket-frog eggs from any of the desirable frog-egg stock.

The peeper, together with the swamp cricket frog, makes up the shrill chorus from our swampy situations in early spring. They often occur in the same situations as the leopard frog, but the eggs of the peeper (fig. 1, *C*) are laid separately (Pl. XIX, fig. 1), do not occur in masses, and are hard to find. Hence there is little danger of their confusion with those of the leopard frog, though laid at the same time.

The cricket frog is one of the first forms to appear in the spring and according to several authors breeds in March, April, and May or even later. Abbott[a] says the small masses of eggs are attached to blades of coarse grass along ditches in the meadows. The writer recently found them breeding actively on June 1. They had chosen a shallow (1 to 4 inches deep), grassy meadow pool (Pl. X, fig. 1). The eggs were attached singly to sedge stems or were strewn singly on the bottom. In one or two instances three or four eggs were close together. Many of the eggs were in water not more than an inch in depth.

The larger tree frogs, like the common tree toad, Carolina tree frog, and the pine wood's tree frog, lay their eggs from the very last of May to July. The color of the eggs is brown on the upper half and cream or yellowish on the lower half. On the criterion of color alone they might possibly be confused with those of the pickerel frog, which deposits eggs, the upper halves of which are brown and the lower yellow or orange. The latter species, however, lays its eggs from April 20 to May 20 before the tree frogs begin. Besides, its egg masses are spherical, 2 or more inches in diameter, and are found beneath the surface of the water. These tree frogs lay at the same period that the green frog and the bullfrog do and, as do these, lay their eggs in films on the water (Pls. XVI, fig. 2, and XVIII, fig. 1). But the bullfrog and green-frog eggs occur in large films 2 to 8 inches in diameter, while the tree-frog films are seldom over 1½ inches. Occasionally, the large egg films of the bullfrog and green frog break up into smaller films, but then they can be distinguished from the tree frogs by the fact that the egg is black above and white below.

The narrow-mouthed toad is a form whose life history is not wholly understood. Brimley[b] holds that it breeds from May to August, and

[a] Abbott, C. C.: Notes on the habits of the "Savannah Cricket Frog." American Naturalist, Vol. XVI, No. 9, p. 707, 1882.

[b] Brimley, C. S.: Batrachia found at Raleigh, N. C. American Naturalist, Vol. XXX, p. 501. Philadelphia, 1896.

the author's limited experience with the species suggests that the eggs are usually laid during the spring or early summer. Deckert[a] found their eggs on August 28. The eggs were "laid in oblong, jelly-like sheets or flat masses about 1½ inches long and 1 inch wide. The egg masses contain about 100 to 150 eggs."

The oak toad breeds in May and June, most of the egg laying doubtless occurring before June 15. The egg string is laid in warm, shallow ponds, and many of these eggs or the subsequent tadpoles are dried up by the rapid evaporation of the very transient breeding pools. The egg string or file is a small edition of the southern toad's egg string, the former being much smaller in diameter than the latter. A female oak toad may deposit 500 to 600 eggs, while a common toad produces 4,000 or more. The eggs of the oak toad are slightly smaller than those of the common toad.

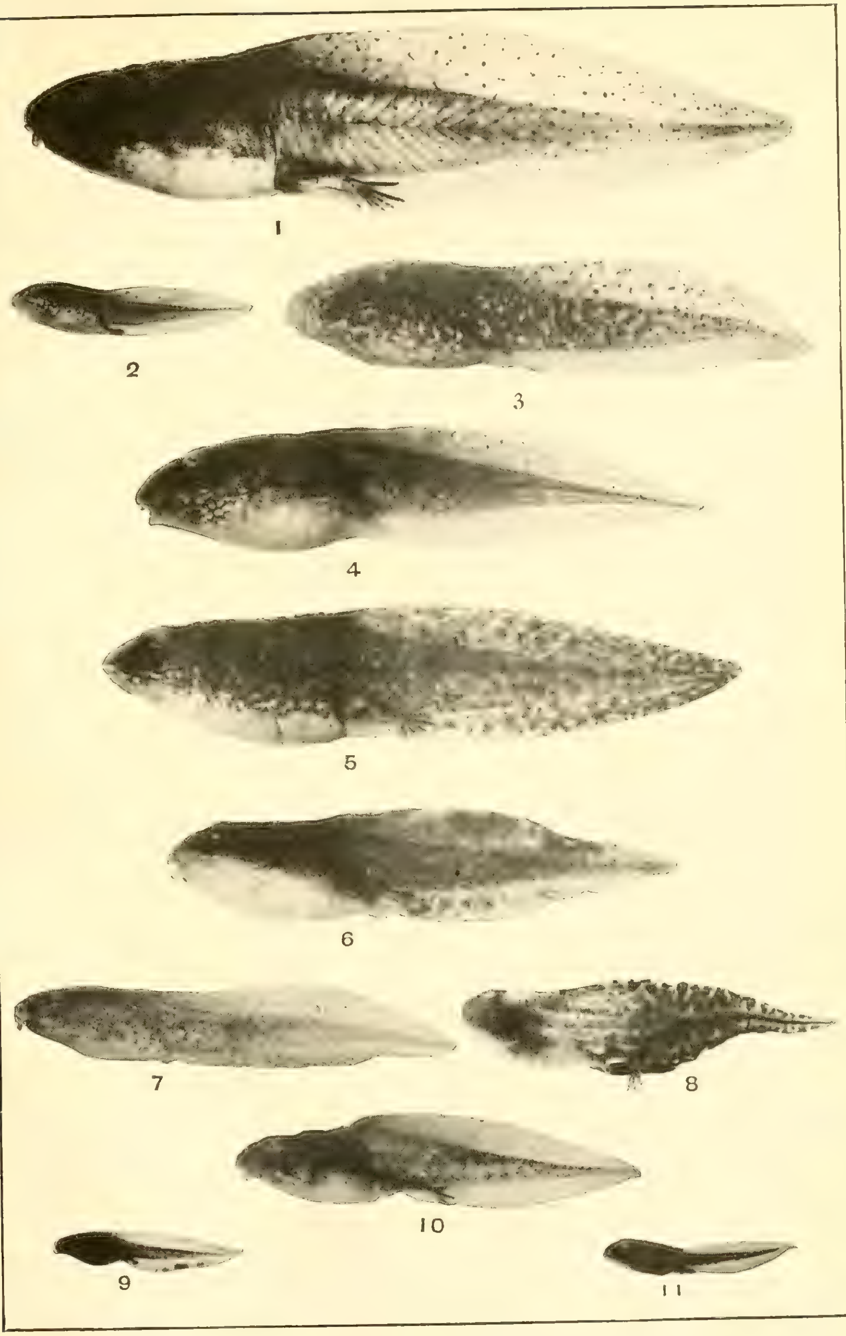
TADPOLES (PL. XX).

For the average layman the tadpole might prove the easiest starting point in attempting frog culture: Individual breeders must be secured just before mating; to take mated pairs is more difficult; the egg period is short and the chances of finding eggs restricted by time and the expertness of the seeker; but the tadpoles of some of the best species may be had at almost any time, the green frog remaining a year in the tadpole stage and the bullfrog two years. There are a few cardinal considerations to be borne in mind: Any large tadpole of the eastern United States found in the spring before May 1 is, so far as we now know, either a green frog or a bullfrog tadpole. Usually tadpoles taken after September 1, and almost surely after October 1, must be of the green-frog or the bullfrog species. Throughout the summer, when the other tadpoles are present, if a tadpole be at least 2 inches or more in length, it is generally either that of a leopard frog, pickerel frog, or bullfrog, all desirable species. In proportion to their size, these commercial frogs have smaller eggs than the smaller species of frogs, and, consequently, the period of tadpole development and growth to adult form may also consume more time both actually and relatively.

Desirable Species.—The tadpoles of the leopard frog transform during the same season in which the eggs are laid. The eggs are relatively larger and the size at transformation is smaller than in the green frog and the bullfrog. Usually 71 to 111 days elapse between egg laying and the change to small frogs, or 60 to 80 days elapse between the hatching of the eggs and transformation. The tadpoles of the leopard frog are very seldom found after August 15. The distinctive marks are: Crests of the tail (not muscular portion) conspicuously lighter than the body, almost transparent, and marked with widely scattered fine spots or specks; belly deep cream color with bronzy iridescence; greatest length, 3 to 3.4 inches. (See Pl. XX, fig. 4.)

The pickerel-frog tadpoles change into frogs the same season the eggs are laid. The developmental period from the egg to transformation consumes from 87 to 100 days; the period from egg hatching to transformation 76 to 85 days. The distinctive marks of the tadpole are: Tail crests not transparent or translucent, as in the leopard frog, but opaque, very dark, sometimes almost purplish

[a] Deckert, R. F.: Further notes on the Salientia of Jacksonville, Fla. Copeia, No. 9, p. 1, 1914.



FIGS. 1 TO 11.—MATURE TADPOLES, NATURAL SIZES.

1, 2-year-old bullfrog tadpole; 2, 3 to 5 months old bullfrog tadpole; 3, 1-year-old bullfrog tadpole; 4, leopard-frog tadpole; 5, 1-year-old green-frog tadpole; 6, pickerel-frog tadpole; 7, 3 to 6 months old green-frog tadpole; 8, tree-toad tadpole; 9, peeper tadpole; 10, wood-frog tadpole; 11, common toad tadpole. (After Wright, Carnegie Publ. No. 197.)

black, and usually marked with aggregate spots or blotches somewhat like the green-frog tadpole. In the pickerel-frog and leopard-frog tadpoles, in spite of the coppery iridescence on the belly, the elongate intestine shows through the skin, while in the green-frog tadpole the deep cream color hides the view of the intestine. The pickerel-frog tadpoles never reach 3 inches in length. (See Pl. XX, fig. 6.)

The green-frog tadpole requires one year for growth before it becomes a small fully formed frog. The same factors operate for this extension of time as in the case of the bullfrog tadpole. The tadpole of the green frog, however, has to attain a size slightly more than one-half that of the mature bullfrog tadpole, and the larval or tadpole period is, therefore, one-half as long. The distinctive marks are: Tail greenish, mottled with brown; belly deep cream color with very little or no iridescence; no round black spots; never over $3\frac{1}{2}$ inches in length. (See Pl. XX, figs. 5 and 7.)

The bullfrog tadpole requires two years or more for growth before it transforms or becomes a frog in form. This long period of development results from several causes, among which are these: The eggs are relatively small and are laid late in the season; and the larvæ or tadpoles are hatched in an immature state and have to grow to a comparatively large size before they change into small bullfrogs; that is, the mature bullfrog tadpole may be three times as long as a wood-frog tadpole or twice that of a pickerel-frog or leopard-frog tadpole. Any tadpole over $3\frac{1}{2}$ inches in length will prove to be that of a bullfrog. The distinctive marks are: Belly of a straw or maize yellow color; the body and the tail (except the lower crest of fin) with regular round black spots; and fine yellow dots all over the body. (See Pl. XX, figs. 1, 2, and 3.)

Possible Species.—With the exception of the toad, the tadpoles of several possible forms are not well enough known to describe positively. The toad tadpoles seldom reach more than from 1 to $1\frac{1}{4}$ inches in length. The small size required enables the tadpole to develop quickly into the toad form. The period of development from the egg to transformation is from 50 to 65 days; from the hatching to transformation, 41 to 60 days. The distinctive marks of the tadpole are: Body very dark or black (not greenish) in appearance; crests of the tail cloudy transparent or milky translucent and not high; tail tip often more or less rounded. (See Pl. XX, fig. 11.)

The tadpole of the wood frog develops in one season; usually the period of development from the eggs to transformation extends over about 90 days, though the range may be from 61 to 115 days. The tadpole period and breeding time of the wood frog coincide with those of the leopard frog. The tadpole of the wood frog never becomes more than 2 inches long. Like that of the leopard frog the belly of the wood frog has a bronzy iridescence, but it is more pinkish in the latter along the upper-jaw region, while the wood-frog tadpole has a cream-colored line; finally, the mouth of the tadpole of the wood frog has three rows of teeth on the upper jaw and four rows on the lower jaw, while all the desirable species have two rows of teeth on the upper jaw and three on the lower. (See Pl. XX, fig. 10.)

Undesirable Species.—Some of the more frequent tadpoles which should be avoided are those of the narrow-mouthed toad, the tree toad, the peeper, the swamp cricket frog, and the cricket frog.

The narrow-mouthed toad, so far as known, transforms the same season during which the eggs are laid. This period was formerly considered to be 90 to 100 days, but Deckert's[a] captives required only 16 days from hatching to transformation, an amazingly short period. The largest of the tadpoles of this species reach a length of $1\frac{3}{8}$ inches and are very easily distinguished from those of other species. The body is very flat, and the depth of it is contained $1\frac{1}{2}$ times in the width, while other tadpoles have round bodies; there is no spiracle; there are no horny-edged mandibles, and the lower lip of ordinary tadpoles is not present, while the upper has either a faint row of teeth or none at all. The color of the tadpole is quite conspicuous. On the back and sides it is a uniform brown or olive black. Along the middle of the muscular part of the tail there is a bright, clear, white band one-fourth to one-half inch long. Along either side of the belly there is a similar white line, and most of the belly is of this clear white. All in all, it is our most remarkable tadpole.

The known tree-frog tadpoles of this country, with the exception of the peeper, have the two rows of teeth on the upper lip and two on the lower, thus differing from the desirable frogs which have two rows on the upper and three on the lower. Furthermore, the upper tail crest (this is also true of the peeper tree frog) extends onto the back almost to between the eyes, which are lateral, visible both from the back and belly. In the tree-frog tadpoles the eyes are not visible from the lower side of the animal, and the tail crest seldom reaches onto the back beyond the vertical of the spiracle.

The common tree-toad tadpole takes about 50 or 60 days for development from the egg to the transformed tree toad. Sometimes the period may be no longer than 45 days or, in other cases, as great as 65 days. These tadpoles can be distinguished at once by their long tails, which are 2.2 to 3.5 times the length of the body and scarlet or orange vermilion in color, with black blotches more prominent near the margins of the crests. The belly is conspicuously of a white or light cream color, slightly iridescent, and the intestine does not show through. These tadpoles reach a length of 2 inches. (See Pl. XX, fig. 8.)

The peeper tadpole may have the rows of teeth two and two, as in American tree frogs in general, or some of the tadpoles may have a small third goateelike row on the edge of the lower lip. The peeper tadpole transforms about 90 or 100 days after egg laying and never exceeds 1.3 inches in length. The tail is only 1.4 to 2.1 times the length of the body. The tail crests are clear and usually heavily pigmented with purplish black blotches near the outer edges. (See Pl. XX, fig. 9.)

The swamp cricket frog spends about 75 to 100 days in passing from the egg to transformation. The tadpole is the darkest in color of any tree-frog tadpole; the body is brownish black all over, and the back and the upper two-thirds of the muscular part of the tail have the same color. The lower third of the muscular portion of the tail is whitish. The tail crests are transparent and practically unspotted, a character which is distinctive in an adult tadpole. The rows of teeth are 2–2, or 2–2 with a slight suggestion of a third lower row.

[a] Deckert, R. F.: Loc. cit., pp. 1, 2.

The tadpole of the cricket frog develops in about the same length of time as that of the peeper. The tadpoles of the former transform the same season the eggs are laid and seldom exceed 1½ inches in length. They are larger than peeper tadpoles, have the crests blotched like tree-toad tadpoles, but have not the scarlet color of these creatures. The conspicuous character is the arrangement of coloration on the muscular part of the tail. There are four long bands—the first a brown band from body to tip of the tail; above this a cream white band, followed by another brown band to tail tip; and this surmounted by another short cream white band. There are two rows of teeth on the upper lip and three complete rows on the lower, as in the case of some of the frogs.

TRANSITION STAGES (PLS. XXI AND XXII).

Many of the attempts at frog culture have consisted in carrying eggs through hatching or even in carrying tadpoles through to transformation; but the efforts have ended at the latter stage. In nature, there is always considerable loss of tadpoles particularly just before transformation, and hitherto, in captivity, the same trouble has often been encountered. Some culturists might, therefore, prefer to begin their first efforts with the transformed frogs which have passed the critical stage, and thus avoid this large percentage of loss of stock. In many ways it is easier than gathering mated pairs or eggs and ought to be almost as successful as the capture with a seine of tadpoles or of individual adults at breeding time. At the approach of the transformation the tadpoles continually remain in the shallows. To be forehanded, a person might pull a minnow seine along such an area, particularly if it be somewhat or quite weedy, and obtain four-legged stages with the stumps of the tail remaining. These complete the tail absorption in a few days and are often easier of capture than the spry small frogs along the bank. If one try to make the captures immediately after transformation is wholly completed, he will have considerable success with leopard frogs and pickerel frogs and often secure 50 to 100 frogs at one time. The aquatic forms, the small green frogs and bullfrogs, however, immediately leap into the water at one's approach and never start landward through the vegetation, as the young leopard frogs and pickerel frogs so commonly do.

Desirable Species.—All of the four principal desirable species for the frog market (the leopard frog, the pickerel frog, the green frog, and the bullfrog) transform at an average size of 1 to 2 inches, while all the possible or undesirable species usually transform at sizes below that of 1 inch. Of course, the danger comes in the layman mistaking a growing undesirable form for a transformed frog of a desirable species; but if he thoroughly learns the cardinal characters of the four adult commercial frogs no error should occur, for the young frogs are sufficient replicas or duplicates of the adults to make their identification easy.

Most of the leopard-frog tadpoles change to small frogs in July, although a few may wait until August before complete transformation. The average range of dates extends from June 30 to July 25, with the bulk of the transformations occurring in mid-July, the latest ones recorded being on August 6. At the approach of transformation

the young come out into the open shallows or rest at the edges of the ponds in the thick mats of vegetation. If the season has been very rainy and the mortality consequently low, a region may have almost a plague of small frogs. Then temporary ditches, holes, and transient diggings are filled with these creatures migrating from the water over the land, and these constitute the so-called rain of frogs. This shows the apparent ease with which young transformed leopard frogs can be captured at such rare occasions with pitfalls, but ordinarily the operation is less easy. If the pond about which the frogs are transforming have a heavy growth of vegetation the frogs prove

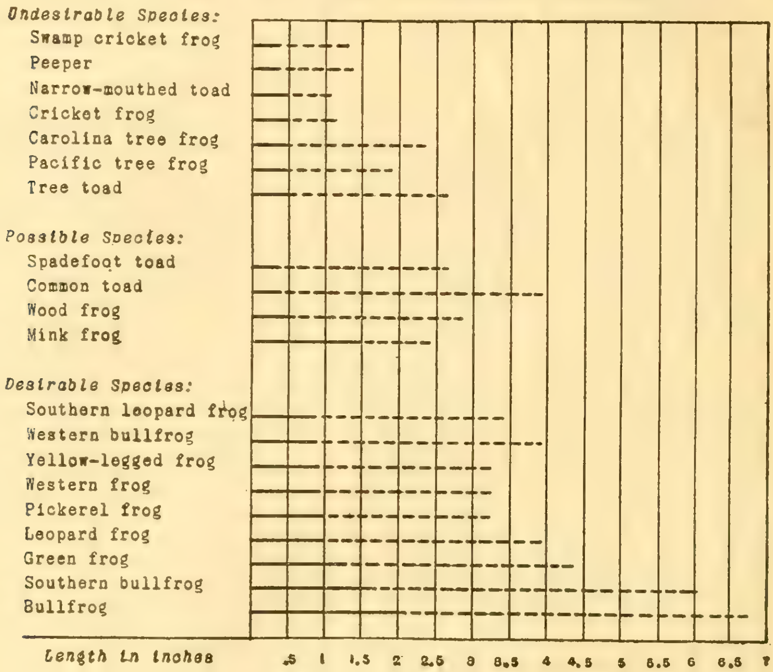
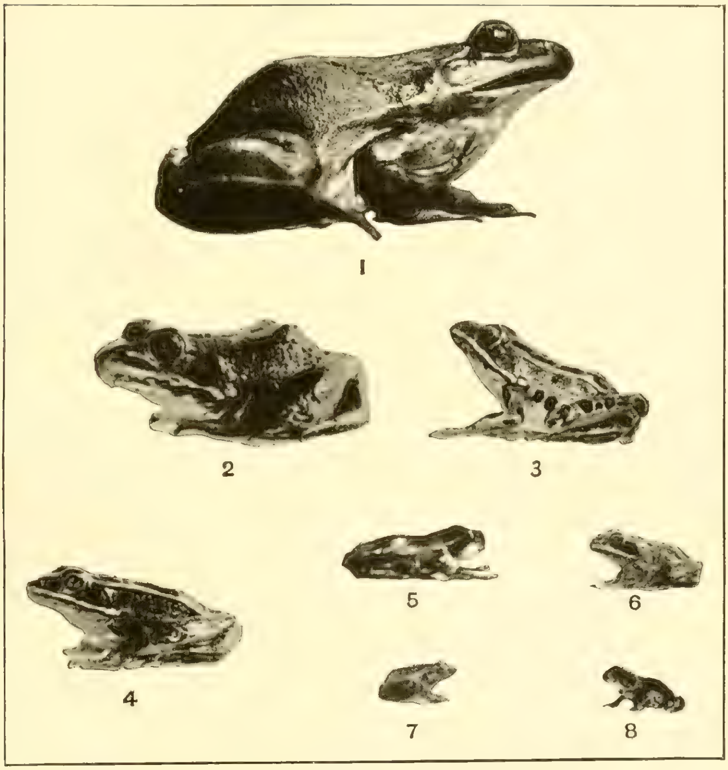


Fig. 2.—Transformation and adult sizes of frogs. Length of continuous line equals the transformation size. Length of continuous and broken lines gives adult size. Adult size determined by largest adult in author's collection.

difficult of capture and are quickly lost in the weeds; therefore, the sure method is to seine the swampy area or pond just before the final stage is reached. At transformation a young leopard frog is, on the average, 1 inch long, the range of size being 0.75 to 1.25 inches. (See fig. 2 and Pls. XXI, fig. 4, and XXII, fig. 6.)

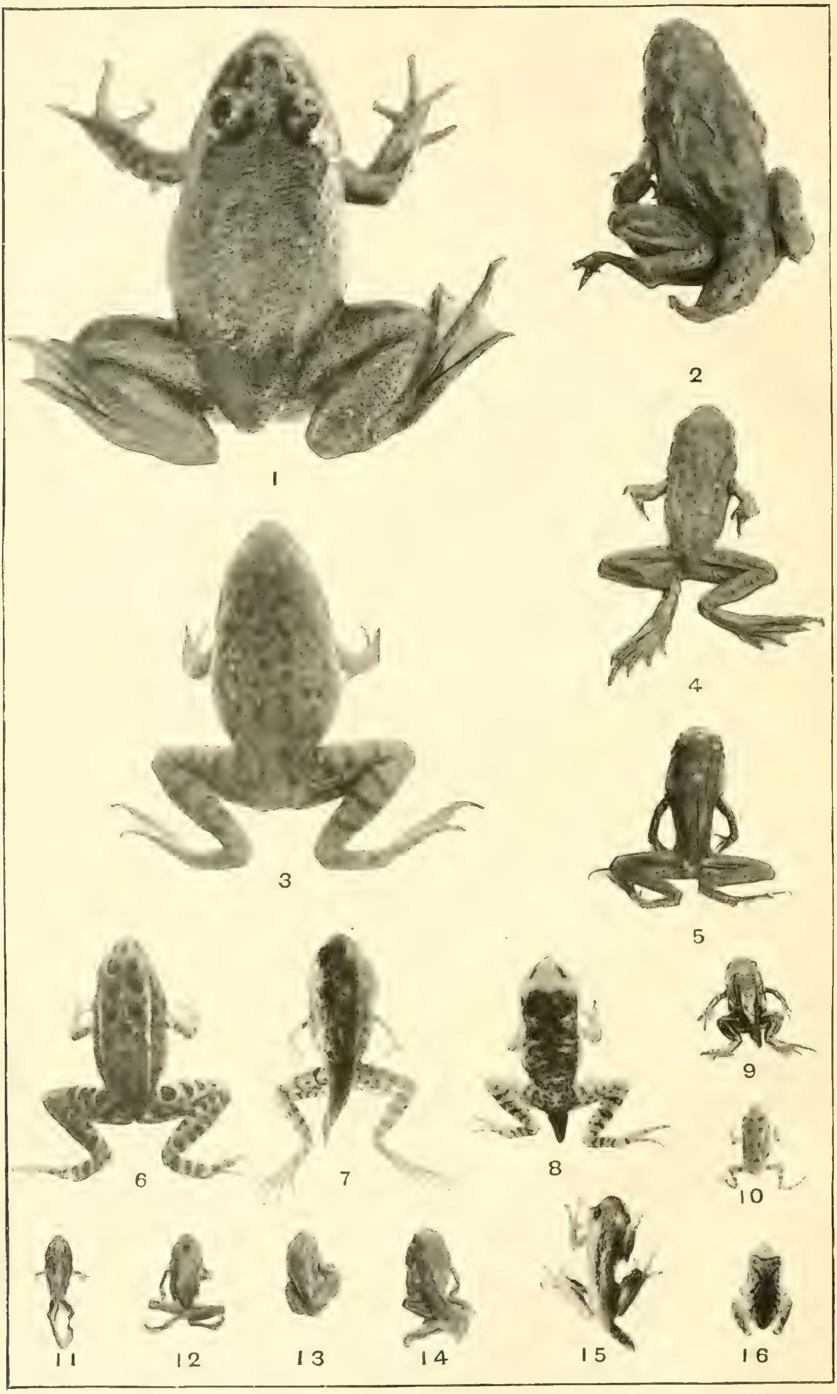
The southern leopard frog transforms during the last of June and in July. The transformed frogs range from 0.75 to 1 inch in length, the average being seven-eighths of an inch. (See fig. 2 and Pl. XXII, fig. 5.)

The pickerel-frog tadpoles may begin to transform the last week in July, but by far the greater number of larvæ transform in August. Occasionally some tadpoles do not transform until September 1 or rarely until October 1. The length at transformation averages 1 inch, and the range of size is 0.75 to 1.1 inches. What has been said



FIGS. 1 TO 8.—TRANSFORMATION SIZES, NATURAL SIZES.

1, Bullfrog; 2, green frog; 3, pickerel frog; 4, leopard frog; 5, tree toad; 6, wood frog; 7, peeper; 8, common toad. (After Wright, Carnegie Publ. No. 197.)



FIGS. 1 TO 16.—TRANSFORMATION SIZES, NATURAL SIZES.

1, Bullfrog; 2, mink frog; 3, green frog; 4, western frog; 5, southern leopard frog; 6, leopard frog; 7, pickerel frog; 8, wood frog; 9, narrow-mouthed toad; 10, common toad; 11, spadefoot toad; 12, Pacific tree frog; 13, swamp-cricket frog; 14, cricket frog; 15, tree toad; 16, peeper. (Photos of 2, 4, 5, 9, 11, 12, 13, 14 from spirit specimens.)

of the leopard frog is more or less true of the pickerel frog. A capital place to secure transformed and half-grown pickerel frogs is along the banks of the headwaters of our clear streams. (See fig. 2 and Pls. XXI, fig. 3, and XXII, fig. 7.)

The newly transformed green frogs vary in length from 1.1 to 1.5 inches, the average being 1.3 inches. Most of the transformations occur in the latter part of June and throughout July. Usually, by the first of August transformation for this species is largely, but not wholly, completed. In a species which lays from the last of May to the middle of August, or later, it is evident that some transformations may occur at any time within the same limits. This form spends one winter in the tadpole stage and is a year old before it changes to the frog form. Of all the commercial forms, this has proved the hardest to collect in numbers at the transformation stage. The long period of transformation, the smallness of some of the ponds and of their green-frog tadpole content, and the shyness of the species make it more difficult to secure a quantity of young green frogs than a similar number of young bullfrogs. It does not seem at present a convenient starting point in the culture of the green frog. (See fig. 2 and Pls. XXI, fig. 2, and XXII, fig. 3.)

The bullfrog tadpole spends two winters as a tadpole. Inasmuch as the eggs are small and deposited late in the season (usually the last of June or in July), the tadpoles are small when winter arrives. The whole of the next season is consumed in growth, and it is not until another winter is passed that the larvæ begin to approach transformation, which usually comes in July—that is, two years after egg deposition. More rarely does the tadpole spend a third winter before transformation. According to all of our data, transformation occurs in July or later. An average of the first dates recorded places the beginning of transformation at July 15, The species evidently does not begin transformation before July 1, and the period of transformation often extends to August 15. In one year, when first recorded on July 30, tadpoles were found which would require two weeks more before transformation. In another year several were found transforming on August 20, and a few other tadpoles which appeared as if they might transform in October or November or during the next season were found. The mature tadpoles begin to come out in the shallow water in early summer. Here they hide in the Chara, Nitella, hornwort, water milfoil, etc., or they rest beneath the lily pads, pond weeds, and other surface plants. Another favorite place of transformation is among the pickerel weed, arrowhead, and water plantain, which afford an overhead cover. Occasionally, around ponds where shallows are absent, stumps of trees, fallen logs, and trees fringe the edge, and their roots extend out into the water. These are favorite transformation sites for the species. At this period they are present in hundreds, or even thousands. The transformed individuals present a spirited sight as one approaches. They are shy, and long before one gets within range start skipping over the vegetation, giving the alarm note so characteristic of the species when surprised. Equally interesting is it when they occupy perches along the stumpy edges of deep ponds. It seems as if a wave of little bullfrogs keeps going before one as he skirts the pond. Inasmuch as this species requires two years to mature, it might naturally be expected that with varying conditions the tadpoles would be of diverse sizes at transforma-

tion, due to inequalities of growth. This supposition is borne out by observation. In none of the species under consideration is there such a range of size at transformation as in the bullfrog, which at this period varies from 1.7 to 2.35 inches in length, with an average of 2.1 inches. (See fig. 2 and Pls. XXI, fig. 1, and XXII, fig. 1.)

Some of the southern bullfrog tadpoles may transform in the very last of May, and the minimum transformation size recorded is $1\frac{3}{4}$ inches. (See fig. 2.)

Possible Species.—The toad tadpole is among the first of the season to transform. When transformation is taking place, the shores of some ponds are black with myriads of little toads, their numbers being particularly noticeable when they leave the shores and cross near-by roads and streets. Transformation begins the last of June and may continue into August and rarely into September. The author's earliest record of transformation is June 8. The average date is June 21. The size at transformation is small, ranging from 0.3 to 0.5 inch in length, the average being 0.4 inch. (See fig. 2 and Pls. XXI, fig. 8, and XXII, fig. 10.)

The wood frog usually begins transformation about July 1. The transformation may begin as early as June 8 or extend to August 1, and the transformation size varies from 0.5 to 0.85 of an inch, the average being 0.6 of an inch. (See fig. 2 and Pls. XXI, fig. 6, and XXII,fig. 8.)

The hermit spadefoot toad transforms from June to August and ranges in size from 0.3 to 0.5 of an inch at the time of transformation. (See fig. 2 and Pl. XXII, fig. 11.)

Undesirable Species.—The undesirable forms, when full grown, are small and the young transformed frogs are also small of size, none of them ranging over 0.8 of an inch and most of them having an average size of 0.3 to 0.7 of an inch.

The narrow-mouthed toad tadpole may transform from the middle of June to September or October. The average size at transformation is 0.5 of an inch. (See fig. 2 and Pl. XXII, fig. 9.) The tree toad transforms largely during the last of July and the first of August. The size at transformation varies from 0.5 to 0.8 of an inch, the average being 0.6 of an inch. (See fig. 2 and Pls. XXI, fig. 5, and XXII, fig. 15.) The peeper tadpole usually begins to transform as early as July 1, although the average date is July 6. The range of transformation is from June 12 to August 1, and the range of size is 0.35 to 0.55 of an inch, the average being 0.4 of an inch. (See fig. 2 and Pls. XXI, fig. 7, and XXII, fig. 16.) The swamp cricket frog usually has finished transformation by July 1 and may transform as early as June 1. At transformation the frog is 0.3 to 0.5 of an inch in length. (See fig 2 and Pl. XXII, fig. 13.) The cricket frog transforms from June 1 to July if the eggs be laid early, or in August if the eggs be laid in June. At transformation it averages a greater length than the swamp cricket frog, being 0.5 of an inch in length. (See fig. 2 and Pl. XXII, fig. 14.)

RATE OF GROWTH.

The rate of growth from transformation to the full-grown adult condition (fig. 2) is very important. If a frog requires a long period to reach adult estate, then such a factor is one item which militates

against the species as a desirable frog for cultural purposes; and other favorable factors must counterbalance if the species is to be kept in the preferred list. If, in nature, two years are required for the bullfrog to pass through the tadpole stage and five or six years more to reach a length of 6 inches, in order to make its cultivation worth while, the dangers and enemies to which it is subjected during those seven or eight years must be overcome or reduced, or else the numbers of bullfrogs must be increased by careful handling to allow for the great losses in the course of their growth. Through many years the growth of our food fishes has been observed at our numerous fish hatcheries, but there is next to nothing in the literature of this country concerning the growth of frogs. Some authors have assumed that if, just previous to hibernation in the fall or at the outcoming in the spring, the collector found three or four groups of different sizes, these groups had been hatched in as many succeeding years. There are, however, great variations. A species which laid from May to August might, in the following August, include some frogs 1⅓ of a year old and some 1 year old. For growth studies it is imperative that not only the average and range of transformation size, but also the time of transformation, be known; for example, a small frog little beyond the transformation size if found in May must be almost a year old, because rarely, if ever, does any frog transform earlier than June. The results which the writer presents in the following table are merely tentative conclusions based only on measurements of frogs of all sizes collected at random over a period of 10 years.

Estimated Sizes, Range, and Average of Certain Frogs at Yearly Intervals of Growth, Shown in Inches.

	Transformation.		1 year old.		2 years old.		3 years old.		4 years old.	
	Range.	Average.	Range.	Average.	Range.	Average.	Range.	Average.	Range.	Average.
Pickerel frog	0.75–1.1	1.0	1.1 –1.75	1.5	1.75–2.1	1.875	2.1 –2.45	2.3	2.45–2.75	2.6
Leopard frog	.72–1.25	1.0	1.25–1.75	1.5	1.75–2.2	2.0	2.2 –2.5	2.35	2.5 –3.0	2.7
Green frog	1.1 –1.5	1.3	1.5 –2.05	1.8	2.05–2.6	2.25	2.6 –3.15	2.85	3.15–3.85	3.5
Bullfrog	1.7 –2.35	2.1	2.35–2.85	2.6	2.85–3.6	3.25	3.6 –4.4	4.0	4.4 –5.2	4.75
Wood frog	.5 –0.84	.62	.84–1.15	1.0	1.15–1.59	1.375	1.59–2.05	1.8	2.05–2.55	2.25
Tree toad	.56–0.81	.62	.81–1.15	1.0	1.15–1.6	1.375	1.6 –2.0	1.8	....	......

In most of these forms the frog reaches the breeding condition in four years, and in the case of the pickerel frog, leopard frog, and green frog some individuals may possibly breed when 3 years old. The bullfrogs which reach 7 or 8 inches in length must require seven or eight years for such a growth. In all the forms, a growth of an inch a year is unusual, the normal rate being from 0.35 to 0.75 of an inch a year. The wood frog reaches maturity in four years, and the tree toad in three years. In both, the rate of growth is apparently about 0.35 inch a year.

FOOD.

The food problem is one of the crucial questions in the feasibility of frog culture. No very systematic seasonal study of the food of

our frogs has ever been undertaken and successfully completed. The toad has been quite thoroughly studied throughout its feeding season.[a] The best food investigation of any of our frogs (*Rana pipiens*) covers a very short feeding period from August 8 to 22,[b] while the food of the bullfrog has aroused interest and some attention because of some of its bizarre tendencies. As a consequence, the food of the tadpoles, transformed frogs, and adults of our commoner species can not be spoken of as positively as would become scientific parlance. A summary of what has appeared will have to suffice until comparative studies which are in progress are forthcoming.

FOOD OF TADPOLES.

In the earlier days armchair scientists held that the food of a tadpole had to be almost or quite wholly vegetable in nature, because of the elongate intestine the creature possessed; but even casual observers have noted with what avidity tadpoles assemble around a dead fish. The taxidermist knows very well to what a bone-clean condition tadpoles reduce carcasses of mammals, birds, or cold-blooded vertebrates. Several experimenters in frog culture have maintained that they could raise tadpoles on dressed submerged fish or on liver, a well-known fish food. These animal tendencies in the diet of an apparent vegetarian extend even to the devouring of their own kind under stress of unusual circumstances. It must, however, be remembered that most of this animal food, if not all of it, is dead and immobile. Seldom do they prey on larger aquatic animals or even on the smaller forms, unless these incidentally occur in the food stream which is mainly vegetable in character. Their animal-feeding proclivities are mainly those of scavengers, and it is therefore hardly correct to call them carnivorous or omnivorous, as has been done by some. Up to the present time there has been no serious extended examination of the food of tadpoles, because of the enormity of the task and on account of the previous uncertainty of the identification of the frog species to which they belonged.

FOOD OF TRANSITION STAGES.

This period when the tadpole changes to a small frog is a critical time in the life history of any individual frog and is in many ways the most important point of attention for the frog culturist. The creature makes a complete change of form, becomes truly carnivorous, spends some of its life on the banks or in the fields, and therefore can not be expected to adjust itself in an instant to a new existence. Dr. Philip A. Munz, who is studying the food of transforming and transformed frogs, presents the following preliminary and provisional summary from his examinations:

> Thus far a fairly representative series of each of the following species of Rana has been studied: *R. catesbeiana*, the bullfrog; *R. clamitans*, the green frog; *R. sylvatica*, the wood frog; and *R. palustris*, the pickerel frog. In each species the same general tendencies are evident:

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[a] Kirkland, A. H.: The habits, food and economic value of the American toad. Hatch Experiment Station of the Massachusetts Agricultural College, Bulletin 46, April, 1897, Amherst, Mass.; also, Usefulness of the American toad, U. S. Department of Agriculture, Farmers' Bulletin No. 196. Washington, 1904.
Garman, H.: Kentucky Experiment Station Bulletin No. 91. 1901.
Hodge, C. F.: Nature study leaflet. Worcester, Mass., 1898.

[b] Drake, Carl J.: The food of *Rana pipiens* Schreber. Ohio Naturalist, March, 1914, Vol. XIV, No. 5, pp. 257-269. Columbus.

(1) The larval alimentary canal is very long, but slightly differentiated in its various portions and filled with ooze and silt scraped up from the objects in the pond and containing many species of diatoms, blue-green and green algæ of filamentous and nonfilamentous forms, small pieces of green plant tissue, and bits of fibers and other nondecaying material found in ooze. As yet I have found no tadpoles containing animal tissue, but as is generally known, they nibble off small pieces of flesh when it is available. Insects, mites, spiders, etc., are quite universally absent from the larval food; even the small water crustacea are rarely met with.

(2) After the fore and hind legs are both in evidence and the horny plates of the tadpole mouth are shed, the tail is gradually shortened and the alimentary canal shortens to become dilated anteriorly and posteriorly, forming the stomach and the rectum, the latter communicating with the cloaca. During this time there is practically no food taken in, although the fat in the body cavity is scarcely reduced in amount; evidently the material available as the result of the absorption of the tail is sufficient. The epidermis is evidently shed often during the absorption of the tail; for in many cases, especially in the bullfrog which is large enough for it to be more apparent, epidermis is present in the alimentary canal; this tendency to swallow the cast epidermis seems quite universal. Occasionally a few algal filaments seem to become entangled in it and are then present in the stomach contents.

(3) After the tail is reduced to a mere remnant with a length of 1 to 2 millimeters (0.4 to 0.8 of an inch) and the mouth has increased to several times its former size, the alimentary canal has become from one-sixth to one-tenth of its larval length, and the young frog again begins feeding, now taking mostly animal food. The range of forms consumed is very great, each species of frog apparently eating anything alive and moving and yet small enough to swallow. Crustacea, Isopoda, Acarina, Arachnida, and almost every group of Insecta have been found. The forms fed upon are not aquatic to any extent, but feeding is done largely above and near the water. Naturally such life as is to be found on or near the ground is most available and the stomach content is largely ground beetles, plant lice, springtails (Collembola), leaf hoppers, snout beetles, spiders, mites, sow bugs, ants, and small flies. Of the molluscs, snails are occasionally met with, and of the vertebrates only a few have been observed, such as young frogs and toads in young bullfrogs.

The differences in selection of food may come under two categories: (*a*) Those due to the size of the species of frog—the bullfrog, for example—can and does eat much larger forms than can the smaller species, and yet it also takes the smallest mites; and (*b*) those due to the location and nature of the ponds from which the specimens were taken; for in different locations are to be found different food materials. But as yet I have been able to observe no difference in the range of insects or other forms eaten by each species,

By way of summary, then, the tadpole is largely herbivorous; the transforming individual does but little or no feeding, and the young frog is carnivorous, eating plant and inorganic materials perhaps as a matter of accident while seizing insects or other prey.

FOOD OF ADULTS.

Growing and adult frogs are carnivorous. To be sure, they may accidentally take in vegetation or mineral matter, but this is an incident to their pursuit of moving prey or synchronous with the swallowing of their own cast skins. If their prey remains quiet it may escape. If our frogs pursued their prey in the water as do fishes there would be no particular need for a tongue, and some of the most aquatic frogs of the world have little or no tongue as a consequence. Practically all of the frogs of the United States are possessed of a good, thick, adhesive protrusible tongue, which is fastened at its forward end. The posterior end of the tongue can be shot forward and then quickly retracted with the prey affixed or held.

It must be remembered that our frogs do not pursue their prey beneath the water; therefore it becomes evident that practically all food prehension for our species takes place at or above the water's surface, on the shores of bodies of water, on the banks of streams, in the meadows, or in some cases in the trees. Some remain in favorable position and capture the passing prey; others hop toward

their prey until within range; still others occasionally stalk their prey; and a fourth group, like the tree frogs, may at times leap into mid-air for their game.

The tongue is the main organ of prehension, but the forefeet are often used in a ludicrous manner to help in forcing into the mouth a difficult or cumbersome object. If one tries to force food or other objects into the mouth of a captive frog, however, the same feet may often be employed to prevent the operation.

A general summary of the various food elements as thus far determined by previous authors follows.

Vegetable matter.—What Kirkland [a] found true for the toad obtains more or less for our species of true frogs. He held that—

> Vegetable material formed less than 1 per cent and from its character appears to have been taken by accident and can not be properly considered as food. Since the toad takes the greater part of its food from the ground by means of its large, fleshy tongue, nothing can be more natural than that a small quantity of vegetable detritus should be swept into the mouth along with the insects on which the animal feeds. The most common vegetable substance found in the stomachs is grass, both dry and fresh. Bits of rotten wood, broken acorn shells, seeds of the linden (*Tilea americana*) and maple (*Acer saccharinum*) and bits of apple parings have also been detected. All these vegetable substances were usually associated with a large quantity of ants and other terrestrial insects.

Possibly the more aquatic frogs, like the bullfrog and green frog, might take more vegetable matter than the more terrestrial leopard frog or wood frog. The former have a feeding ground where the algal carpet of the water's surface may be the alighting ground for the prey, or where the wet, broken vegetation of the shore may be the hiding ground of numerous insects.

Mineral matter.—Of this habit Kirkland writes the following: [a]

> The mineral matter found in the stomach forms slightly more than 1 per cent of the total contents and consists of gravel, sand, and, in a few cases, coal ashes. When a large piece of gravel is swallowed it is regurgitated; this I have proven by experiments on toads in confinement. Otherwise the gravel passes through the alimentary canal and may be found in the castings. Since the toad does not masticate its food, but depends on the stomach for the whole process of trituration, it is probable that the gravel when present assists in grinding the strongly chitinized bodies of beetles, etc., yet in the majority of the toads examined there was no gravel present in the alimentary canal, although many of the stomachs contained finely ground beetles. A proper inference from the above is that gravel is not essential to digestion in the toad, and the writer inclines to the opinion that, as in the case of the vegetable matter, the presence of gravel in the stomachs is the result of accident rather than of design.

Animal Matter.—No doubt, in the case of our four principal commercial species this element constitutes from 97 to 98 per cent of the food, as in the toad.

Mollusks.—Mollusca are seldom eaten by the wood frog and pickerel frog and constitute about 1 per cent of the food of the toad and about 3 per cent of that of the leopard frog. Mollusca no doubt enter to an appreciable extent into the diet of the more aquatic forms of anurans. Surface [b] found the green frog alone had eaten mollusks to any extent, while Dyche [c] found 12 of his 30 bullfrogs had eaten snails, one having 9 in its stomach.

Worms.—These enter into the nocturnal toad's diet more than into that of any other species and constitute 1 per cent of its diet. Worms

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[a] Kirkland, A. H.: Loc. cit., pp. 13–14.
[b] Surface, H. A.: Bi-Monthly Zoological Bulletin. Division of Zoology, Pennsylvania Department of Agriculture. Vol. III, Nos. 3 and 4. 1913.
[c] Dyche, L. L.: Ponds, pond fish, and pond-fish culture, pp. 150–153. State Department of Fish and Game, Kansas. Topeka, 1914.

have been recorded in the food of the leopard frog but are rare in the food of the other four common species of frog.

Spiders.—Spiders and their relatives are eaten by the smaller forms like the cricket frog, swamp cricket frog, peeper, and tree toad, as well as by all of the larger forms. "Spiders occur in the stomachs of the toad in all months, but form only 2 per cent of the total food."[a] In the case of the leopard frog, according to Drake,[b] they constitute 27 per cent of the food of the species and are, next to beetles, the largest single item, while in the wood frog, pickerel frog, green frog, and bullfrog, spiders form 8 to 12 per cent of the food of these forms.

Crustaceans.—The smaller forms, like the cricket frog, swamp cricket frog, peeper, and tree toad, very rarely, if ever, eat small crayfish, and only in very shallow water or in pools which are drying up do the leopard frogs attempt an extensive diet of crayfish. There are no records of these creatures being used as food by the pickerel frog, wood frog, or toad, the two latter being quite terrestrial. The more aquatic creatures—that is, the green frog and the bullfrog—eat them, the first to the amount of 4 or 5 per cent, while the last, being larger, makes them 20 or 25 per cent of its whole diet. The opposite condition obtains in the case of the sow bugs, since the bullfrog does not eat them and the green frog very seldom, while the more terrestrial leopard frog may make sow bugs 4 or 5 per cent of its food. These creatures form 2 per cent of the toad's food, and the pickerel frog also occasionally eats them.

Myriapods.—"Myriapods [according to Kirkland [a]] form a constant article of diet for the toads. * * * These creatures form 10 per cent of the food for the season." They constitute 1 or 2 per cent of the food of the leopard frog, 4 or 5 per cent of the food of the pickerel frog, and 5 or 6 per cent of the food of the green frog.

Insects.—Insects are the main food reliance for frogs, tree frogs, and toads. Five orders, possibly a sixth (Diptera), enter largely into their dietary list. The five principal orders are Coleoptera, Lepidoptera, Hymenoptera, Hemiptera, and Orthoptera. The evidence serves again to prove that these amphibians get most, if not all, of their food above the water or outside of it.

Coleoptera, mainly ground, lamellicorn, and click beetles, and weevils constitute 27 per cent of the food of the toad, while in the animal food of the leopard frog beetles form 33 per cent of the whole, the principal groups being ground, tiger, and snout beetles. In the food of the wood frog, pickerel frog, and green frog the proportion is equally large, while in the diet of the bullfrog the beetle element is surprisingly large; no doubt, water beetles of the surface enter into the food of the bullfrog more than into that of the other species of frog.

Lepidopterous (moths and butterflies) larvæ prove very tempting morsels to toads and make up 28 per cent of their food, while this order constitutes 13 per cent of the leopard frog's diet, about 15 to 17 per cent of that of the wood frog, pickerel frog, and green frog, and only about 5 or 6 per cent of that of the bullfrog.

Hymenoptera form an appreciable part (19 per cent) of the food of the terrestrial forms like the toad. In the diet of the smaller tree frogs and of the young of the larger forms, hymenoptera (ants, etc.),

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[a] Kirkland, A. H.: Loc. cit., p. 15. [b] Drake, Carl J.: Loc. cit., p. 265.

together with flies, replace the beetles of the adults. In the food of the wood frog and of the pickerel frog this order of insects constitutes 4 per cent, or less, and is a negligible factor in the green frog's and bullfrog's diet.

Orthoptera: Roaches, crickets, and grasshoppers make up a prominent part of the food of the adult leopard, wood, and green frogs, while mole crickets not infrequently enter into the diet of the bullfrog. Orthoptera furnish 3 per cent of the animal food of the toad.

Hemiptera: Bugs enter but slightly into the food of the wood frog and bullfrog, form less than one-half per cent of the food of the toad, 4 per cent or less of the leopard frog's diet, 8 per cent of that of the green frog, and 12 per cent or more of that of the pickerel frog.

Diptera: Flies and their relatives form $1\frac{1}{2}$ per cent of the food of the leopard frog and one-half per cent of that of the toad. They are rather a negligible factor in the food of the large forms, while in such creatures as the cricket frog they may play a prominent rôle.

Vertebrates.—Vertebrates enter but seldom into the diet of any but the largest forms, such as the bullfrog. Dyche[a] records the finding of bullheads, crappies, sunfish, goldfish, bullfrog, and other frog tadpoles in the stomachs of bullfrogs. There are extant records of unusual food, like young ducklings, sparrows, mice, snakes, and young newly hatched alligators, in the food of this same species. The other frogs are too small of maw to essay the devouring of any vertebrates.

ENEMIES.

No article is more sought for or more relished as a food by a diversity of animals from fish to man than frogs. The latter's defense consists in concealment and in the possession of poison glands in the skin, neither of which means is aggressive in its nature. Insects and plants may prove a more constant fare, but to any fair-sized animal a frog diet is one of the preferable menus, if obtainable.

Invertebrates: One would naturally think the insect and small animal life of the inland waters was a negligible factor in the reduction of the number of frogs, tree toads, and toads. But for the tender early larval stages and even for the more mature tadpoles these are very serious foes. Anyone who has collected a miscellaneous mass of aquatic life and put it all in one jar knows from dear and sad experience that these small creatures of the water often prey upon and kill the confined tadpoles and small frogs. In the open, especially at night, has the writer seen adult peepers and swamp cricket frogs or their tadpoles in the fatal grip of giant water bugs. Other aquatic bugs, like the well-known Zaitha, walking sticks, and, not least, the back swimmers, make life precarious for tadpoles or miserable for adult frogs in the water. The water beetles, especially their larvæ (water tigers) and dragonfly nymphs also take their heavy toll of tadpole lives. Many of the smaller, almost microscopic, crustaceans, like daphnia and others, are reputed to be incessant enemies covering the whole bodies of the tadpoles. Some of the larger crustacea, like the crayfish, may possibly take the live tadpoles, but it can not be definitely stated that they do. Mosquitoes, gnats, etc., pester frogs and tree frogs when out of the water, but in general little is known of this matter, because it usually happens at night when man is seldom observant.

[a] Dyche, L. L.: Loc. cit., pp. 150–153.

Fishes.—Fish which are almost wholly restricted to the same habitat as frogs might be considered the most serious foe of the early aquatic stages of the frogs and toads. It is very doubtful, however, if their depredations compare with those of the aquatic snakes. In the quiet waters where tadpoles frequently resort the worst depredators are the members of the pike family. From the lunge down to the little grass pike is a series of forms which revel in frogs and their tadpoles. Equally appreciative of small frogs and tadpoles are basses, but some of the larger, like the smallmouthed bass, are not abundant in the habitat of frogs. Forms of the quiet water, like the largemouthed bass and sometimes the rock bass and others of similar habits and of equally large maws, feed on them. The omnivorous catfishes sometimes eat the young tadpoles, the growing frogs and the trouts especially do. The horned dace and some of the larger voracious minnows occasionally eat the newly hatched larvæ of frogs.

Amphibians.—The aquatic salamanders, like the newt, frequently pull off eggs from a frog's egg mass for food. The larger forms, like the mudpuppy (Necturus) and hellbender (Cryptobranchus), may eat frog's eggs or larvæ if favorably situated. Among frogs there are several species whose adults do not stop at fratricide or cannibalism. In fact, it is one of the factors which has led some frog culturists to abandon bullfrogs, which will feed on anything from insects to small alligators, not even sparing their own progeny.

Reptiles.—In this group we find some of the most inveterate and merciless foes of frogs. In the southern States an archenemy is the alligator. Among the turtles the snapping turtles lie in wait for frogs and their tadpoles, while the more alert and active soft-shelled turtles may at times pursue them. The equally vicious musk turtle also is a foe of the frog. The spotted and painted turtles and some of the other "sliders" or so-called terrapins are said to feed on tadpoles, but of this the writer has no first-hand evidence.

The snakes, both aquatic and semiaquatic, are the worst pests the frog has to meet. Among the cold-blooded vertebrates there is no more relentless preying of one thing upon another than the persistent hunting by day or, better, by night of a ribbon snake or water snake for frogs. In fact, frogs are, par excellence, the food of the aquatic snakes. Several of the semiaquatic garters eat or prefer true frogs, cricket and swamp cricket frogs. The very aquatic water snakes (Tropidonotus) of several species, are the worst offenders and at times feed exclusively on frogs. The rainbow and red-bellied (Farancia) snakes also feed on frogs or their tadpoles. On the land the spreading adder is the main enemy. The black snake and garter snakes are quite partial to them, and the pilot snake, copperhead, or ground rattlesnake do not scorn them.

Birds.—Whoever plans to raise frogs must beware of several of our largest and most distinctive forms of birds. The herons and bitterns are the most serious frog eaters. Their long legs and toes equip them for wading, and their long necks and bills are adapted either for a silent waiting game or a slow, stalking search. They frequent the shallows where the tadpoles and transforming frogs are abundant. The great blue heron, the little green heron, the little blue heron, and some of the less familiar forms of the South wait

long periods or slowly patrol in the open stretches of lakes, ponds, and streams for their game. The bitterns inhabit the cover of the marshes and stalk their prey. Among the hawks, the various species of kites feed upon frogs, but because of their rarity are a negligible factor. The marsh hawks eat some frogs. The despised Cooper's hawk rarely takes to a frog diet, while the red-shouldered hawk and sometimes the broad-winged hawk eagerly seek frogs. Into the diet of owls frogs seldom enter, the barred owl most frequently being the depredator. W. B. Barrows [a] found that no food occurs more regularly in the crow's stomach than frogs and toads. In April to July it is the largest live animal item, except insects, in the crow's diet. Of the kingfisher frogs need to beware, though they are seldom seen with frogs or tadpoles, fish being the usual fare. Bronzed grackles eat frogs but rarely. The totipalmate birds, like the snakebird, cormorant, and pelican, are largely fish eaters, but they, no doubt, pursue and capture some frogs. Several ducks are reputed to eat frogs, and one, the hooded merganser, is often called the "frog duck." It would also be well to bear in mind the charge that domestic ducks eat the tadpoles and occasionally the transformed and transforming stages.

Mammals.—In this country the four-footed mammals which eat frogs are very few. Most of these belong to the weasel tribe. The skunk enjoys a good frog when he can catch it, and the mink quite frequently varies his diet with them. The weasels are occasional depredators, but are not comparable to the house or brown rat, which tries anything and everything it can catch. The muskrat is a nuisance in any pond and should be held with suspicion, as should the raccoon. Some individual domestic cats have been known to develop a fondness for frogs, and particularly for tadpoles.

Man is not content with cleaning up and draining the "frog holes" or swampy stretches, but he kills the frogs at all seasons. Few, if any, of our State legislatures see fit to protect them and establish open and closed seasons. As a result, they are taken mainly when they congregate for breeding purposes, and such a toll hardly accords with the ideas of conservation held at the present day.

Nine-tenths of the wild supply is secured at the breeding season or just before breeding. Such a profligate expenditure can not long escape our attention. As thoughtless youths many of us often counted our strings of 100, and some of us hunted them regardless of the season.

In the eastern United States the four important commercial forms should not be killed in the wild state before the following dates:

Leopard frog	May 1, or, better, May 15.
Pickerel frog	May 10, or, better, May 20.
Bullfrog	July 1, or, better, July 15.
Green frog	July 15, or, better, August 1.

[a] Barrows, W. B., and Schwarz, E. A.: The common crow of the United States. U. S. Department of Agriculture, Division of Ornithology and Mammalogy, Bulletin No. 6, pp. 50, 51. Washington, 1895.

FRESH-WATER TURTLES: A SOURCE OF MEAT SUPPLY

By

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and

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Appendix VII to the Report of the U. S. Commissioner of Fisheries for 1919

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FRESH-WATER TURTLES: A SOURCE OF MEAT SUPPLY.

By H. Walton Clark, *Scientific Assistant*, and John B. Southall, *Shell Expert, Fisheries Biological Station, Fairport, Iowa.*

INTRODUCTION.

Among the aquatic food resources of the United States to which but little attention has as yet been given are the several species of edible turtles and terrapins of the rivers and lakes. One species of turtle, the famous and much-sought-after diamond-back terrapin, has indeed long been utilized to the fullest extent consistent with the preservation of the species; and in recent years its propagation on privately controlled farms has been inaugurated. The green turtle of the sea has also for a long time been so generally esteemed and extensively fished as to have been brought into actual danger of extinction. It is worthy of note that, while these two species have been regarded as delicacies of a high order, their relatives of the interior waters have been comparatively little utilized, at least under their proper names. It seems quite probable, however, that certain species of fresh-water terrapin have been rather widely used as an illegitimate substitute for the diamond-back terrapin. Within the last year or two a more general interest in the subject of the use of fresh-water turtles as food appears to have developed, and the Bureau has received many inquiries for information in regard to methods of capture of turtles and the preparation of their meat for the table. It is the aim of the present paper to supply answers to these inquiries, so far as the information is at present available. The data herein presented have been secured by the authors through correspondence with dealers in turtles and by personal visits to many markets in the larger and smaller cities of the Middle West and to various points of commercial fishery, principally on the Mississippi and Illinois Rivers.

THE SNAPPING TURTLE.

DISTRIBUTION AND HABITS.

Commercially speaking, by far the most important species of the Mississippi Basin is the snapping turtle, *Chelydra serpentina* (Linnæus) (Pls. I and II), known also in different localities and under different conditions as the snapper, mud turtle, and mossback. Its position in the market and in the consciousness of the people, the methods of its capture, and the like, are so closely bound up with its natural history that, in order to properly estimate its economic status, it is necessary to give in some detail the main facts regarding its habitat and habits.

In the first place, it has a broad geographic distribution, its range extending from Nova Scotia to the Equator and westward to the Rocky Mountains. It is, therefore, one of the most widely known of turtles; and the New Englander who has migrated to the banks of the Wabash, the Ohio, or the Mississippi, or to the prairies of Illinois, recognizes it at once as an old acquaintance. This wideness of distribution indicates a hardiness and an ability to live under greatly varying conditions.

Not less important than its wide geographic distribution is its varied habitat. It is found in a great many different situations—in lakes, ponds, rivers, creeks, marshes, and bogs, and often travels overland a considerable distance from water. Only those familiar with the faunas of woodland ponds know the pretty, speckled tortoise; only the travelers along shaded creeks know Blanding's turtle; and to those who dwell afar from the larger lakes and rivers the soft-shell is known, if at all, only through the medium of books or museums. There are few, however, to whom the snapping turtle is a complete stranger.

In addition to its great variety of habitat, the leisurely habits of the snapper make it familiar. When approached it does not beat a hasty retreat, as do most other animals, but holds its ground against all comers. Many who are fairly familiar with the pond turtles and terrapin know them principally as a sudden splash from a log, and many who visit the sand bars where the soft-shells love to bask know them principally as a streak over the sand, as a splash at the water surface, and as a wake like that made by a big fish. The snapper, however, is the living embodiment of the status quo. He is willing to wait for the closest and most scrutinizing inspection; and, closely gazed upon, his appearance may have much to do with his being used as an article of food. One could not exactly call him handsome; a better statement would be that he looks good enough to eat. His corpulent, bulging body, projecting in rolls from his inadequate shell gives above all else the impression of meatiness. The rough skin, not greatly unlike that of a freshly plucked chicken, and the narrow cartilaginous bridge and small plastron all suggest easy preparation, much edible material, and little waste.

All the other details about this species—manner of capture, the peculiarities of the market, and, finally, the methods of cooking—are, as will be observed, closely connected with its life history and habits.

SEASONS AND METHODS OF CAPTURE.

During the summer the snappers are rather unsocial. They are solitary in habits, the individuals being widely scattered, so that it is difficult to take an accurate census of them. Because of these solitary summer habits, there is, generally speaking, very little fishing for this species in that season. There may, of course, be local exceptions; thus it was reported that throughout at least part of the summer of 1913, along the Grand River, Mich., there was an active turtle fishery, both snappers and soft-shells being caught in seines and shipped to the large near-by cities, such as Detroit and Chicago. In general, however, the summer is a dull season for turtles. One market man remarked that "the turtle is like the oyster, only in season when the

name of the months contains an 'r.'" Nearly all the other market men explained the situation by saying that "practically all the turtles are used for soups, and few people eat soups during hot weather." The situation is perhaps a little more complicated; it may have to do also with capture and storage. In summer occasional snappers are picked up while on their migrating trips; a few are now and then caught on set lines; and fishermen sometimes catch them in their seines or in baited hoop nets set for fish. It is doubtful whether any of these occasional summer-caught snappers get into the general market. The greater number are released, and a few are locally consumed.

During the autumn and early winter the snappers collect in considerable numbers and hibernate in suitable locations. In the vicinity of Muscatine, Iowa, it was stated that a favorite place for turtles to hibernate is in muskrat holes. According to report, as much as 5 tons of turtles have been taken from the various muskrat holes in one season. Our informant also stated that as many as 26 individuals have been found in one muskrat burrow, while at another time 1,420 pounds were obtained in one run. From 500 to 1,000 pounds of turtle were estimated as a recent catch for one day.

Along the sloughs of the Mississippi they congregate about and under old logs. A specific instance was cited of a fisherman who obtained 20 snappers, weighing from 10 to 20 pounds each, under a log in one of the sloughs of the Mississippi River.

Along the Illinois River, the Cedar River of Iowa, and, indeed, wherever there are springy places near large bodies of water, the snappers "mud up" for the winter.

It is from their hibernating places that the greater number of snappers found on the market are taken, and the captors are usually fishermen or trappers. The methods of capture employed for the various forms of winter quarters—whether muskrat holes, old logs, or springy places—are all, so far as could be learned, very much the same. The implement used is a stout hook, made by bending an iron rod at one end, sharpening the short or hook end, and leaving the other as it is or driving it into a wooden handle to make it better to manipulate during very cold weather. If there is much ice, it is cut and the hook probed or prodded about until a turtle, which feels much like a chunk of wood, is encountered. It is then pulled out by the hook. It is somewhat difficult to land large turtles, although they are benumbed and offer little resistance. The turtle catchers rely upon their hunting instinct to discover the turtles, and when a good place is found many can be taken from it, as indicated in the account given above.

Activity in snapper catching may be stimulated or depressed by widely different circumstances. The general wage scale probably has little influence, since fishermen and trappers are as much attracted by the fascination of their calling as by its emoluments and are not likely to desert their profession for a better-paying job. A high price for pelts and furs may divert greater attention to trapping. One fisherman said that the existence of saloons greatly helped the turtle market, as they dealt extensively in turtle soup. Under favorable conditions the turtle catcher can make very fair wages and still sell the meat at a reasonable price. During the winter of 1918–19 a market man reported: "Turtle meat is the cheapest meat I can buy."

SHIPMENT AND STORAGE.

Generally speaking, the men who catch the turtles make no attempt to hold or store them but ship them to market as soon as they can collect a sufficient quantity.

The turtles are usually shipped in barrels with holes bored through the bottom and through the sides for ventilation and with burlap nailed over the top. In this condition, of course, the contents are not open for observation, and a thriving turtle fishery may be in active operation in a particular region unknown to the general public. Since barrels have become expensive, the catches are sometimes shipped in crates similar to those used for chickens.

Upon arrival at the larger markets the containers may simply be stored in a cool place, where the turtles will remain in hibernation, ready for disposal by wholesale or retail as the market demands. It is with the return of warm weather that the storage question becomes important.

A good many dealers do not attempt to hold turtles at all but pass them to the consumer as rapidly as possible. In the basement of a large wholesale market at Chicago, a cool moist situation, there is a large turtle pen, or, rather, a series of pens, which will hold about 2½ tons of the living animals. They do very well here until summer arives, when the loss is considerable. Here the snappers are washed off occasionally, but the problem of feeding them has not been satisfactorily solved.

It might do much toward stabilizing the market if the intermediate buyers along the rivers, in order to be ready for early fall delivery, would establish large pounds to retain the spring catch, as well as the occasional turtles taken during the summer. It was stated that there was formerly a storage pen at Clear Lake, Ill., where 25,000 or 30,000 turtles could be satisfactorily kept; but that in recent years, owing to changed stream conditions, together with the consequent diminution in abundance of the animals, the pen has been abandoned. At Grafton, Ill., a pound was observed which has been in existence about four years and which was originally designed to retain carp, as well as turtles and terrapin. It is located near the river and comprises a pond supplied by seepage from the river and by rainfall. The size of the pond varies, therefore, according to weather and stream conditions, but at the time observed its dimensions were about 207 by 135 feet. This pond, having banks of considerable steepness, occupies nearly the entire area of the pen. The walls are riprapped with stone and surmounted by a wire fence of 1-inch-square mesh. The pound was said to contain 4,000 or 5,000 terrapin and 2 tons of snappers. It was observed at Grafton, as elsewhere, that quantities of terrapin are always estimated by number, and snappers by weight. Two kinds of terrapin were distinguished; the river terrapin described as "rough," which proved upon examination to be *Graptemys lesueurii*, and the "pond terrapin," described as "striped," which proved to be *Pseudemys elegans*. The former was regarded as much superior to the latter. During the summer, according to information furnished the authors, the turtles had been fed on fishery waste and on hog lights, of which they appeared to be very fond. They were being shipped to the markets of Boston and Philadelphia.

SOURCES OF SUPPLY.

Dealers at Chicago mentioned their source of supply as the Central States—Wisconsin, Minnesota, Iowa, Indiana, South Dakota, and Michigan—although they also received snappers and terrapin from Kentucky. Specific localities mentioned were Winona, Minn., and Guttenburg and Muscatine, Iowa. At one time the Illinois River was an important source of supply during the winter, and parts of it, especially toward the mouth, continue to be so. Kofoid states:[a] "The Illinois River and its backwaters, under present conditions, contribute annually * * * 15,000 dozen turtles" (probably including both snappers and terrapin). During the progress of the investigation of the Upper Illinois in June, 1918, there was no fishing at all on account of the closed season on fishes and, naturally, no capture of turtles.

MARKET CONDITIONS AND PRICES.

The amount of turtles handled by the markets of the large cities does not, of course, indicate the quantity which is consumed locally. As stated above, the winter is by far the most active market season. However, along the rivers the turtles are eaten the year around, whenever they can be obtained, fried soft-shells being especially consumed during the summer. The wholesale market in Chicago previously referred to handles about 10,000 snappers a year, valued at $5,000. Its buyer thinks he could handle a ton a week. Another market handled 1 to 1½ tons a month. The snappers on the Chicago market range in weight from 5 to 25 pounds each. At Peoria they were said to reach a weight of 30 pounds, the average being 7 or 8 pounds. According to the census of 1908, the Mississippi River Basin produced 713,000 pounds of turtles and terrapin, with a value to the fishermen of $25,000.

In these days of uniform prices for standard commodities a striking feature of the turtle market is the variety of prices. A turtle catcher at Muscatine, Iowa, stated that he could get 5 cents a pound live weight or 10 cents a pound dressed at Davenport. He said there was more money selling them alive, as they dressed off more than half, and also the trouble of dressing them had to be considered. One dealer in Chicago sold in wholesale lots at 8 cents a pound and retailed at 10 cents. A buyer quoted them at 6 to 7 cents a pound live weight. At St. Louis it was said that "turtle meat is selling higher than ever before, it being now (June, 1918) about 18 cents; whereas it used to be from 12 to 15 cents a pound."

A published commercial price list (Chicago, 1918) quoted live snapping turtles, usually 10 cents per pound, falling to 9 cents for the week of June 8, to 14, and rising to 11 cents July 20 to 26, 1918, and turtle meat, strictly fresh, 16 to 17 cents, rising during the progress of the summer. In the early part of the season frozen turtle meat was listed at 15 cents.

Many of the points covered above regarding source of supply, prices, and amount handled can best be illustrated by quoting from

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[a] Kofoid, C. A.: Plankton studies. IV. The plankton of the Illinois River, 1894–1899, p. 562. Bulletin, Illinois State Laboratory of Natural History, Vol. VI, 1901–1903, Art. II. Champaign.

a letter received June 4, 1918, from a fish company in La Crosse, Wis., which goes into the subject with unusual fullness of detail:

We receive turtles from all of the commercial fishermen of the Mississippi, no one in particular fishing for them especially, as usually they are caught in such small lots that the average fisherman does not make much of an effort to gather them up. Usually the price this last year has been from 3 to 4 cents, and, getting them in such small quantities, the fishermen figured not money enough in them to bother with them.

We also get quite a few from the Indians who are moving about up and down the river. The general selling price has been (Philadelphia) from 7 to 12 cents, the high price being in the extreme cold weather, and usually the wholesale price runs from 4½ cents f. o. b. shipping stations, and the average quotation from the wholesale houses in Chicago and other places is from 7 to 9 cents.

The following is the amount that we have handled since November, 1917, and conditions were such that we have had to carry quite a lot of this stock on hand, as we were unable to sell it at all times or very readily:

	Pounds.
November	13, 166
December	2, 551
January	1, 689
February	90
March	1, 496
April	5, 206
May	5, 411
Total	29, 609

The demand has been diminishing from year to year. Ten years ago we used to handle them by the carloads and could always find a ready market in New York, whereas at present there is very little demand in New York; in fact, practically none.

The kind of turtle we are handling is what is known locally as the mud or snapping turtle. There is some demand for the soft-shell turtles, but not enough to warrant our handling them.

At Grafton, Ill., it was stated that Boston afforded the best market for terrapin and Philadelphia for snappers.

PROPORTION OF WASTE.

In the consideration of any article to be used for food the item of waste is an important feature, since this must be accounted for somewhere between the producer, or in this case the captor, and the consumer. The opinion of dealers differed somewhat as to the amount of waste in the snapping turtle. It varies considerably according to the manner of cleaning. One dealer thought the turtles would dress off more than half, large ones dressing off less than small ones. Another thought a 12-pound turtle would dress off to 6 pounds, and a 5-pound one to 3 pounds. A dealer at Fort Madison, Iowa, said that by discarding the shell they would dress off two-thirds, but that the shell could be used in making soup, serving as a soup bone. One dealer added that "in making soup the liver and eggs are used, so there is not so much waste." In the Washington market some snappers were seen dressed for sale. The epidermis having been scalded off, and the scutes or epidermal plates of the shell removed, the remaining portion presented a very attractive appearance. Along the backbone of the turtle is a considerable mass of flesh known as "tenderloin," which in rapid or "shop" cleaning is discarded with the shell, but in careful cleaning is saved, thus reducing the waste. At Pekin, Ill., where turtles were cleaned rapidly, discarding tenderloin, liver, and eggs, as well as shell, a 14-pound

snapper furnished 6 pounds of meat. At Fairport, Iowa, one which weighed 11 pounds produced 5½ pounds of meat when carefully dressed, with tenderloin saved, but shell, liver, etc., discarded. The relatively small difference in market prices between live turtles and turtle meat among practiced dressers and dealers (10 cents alive, 17 cents dressed) does not account for so much waste, since one must also consider the labor of dressing the meat.

In considering the subject of waste it may be of interest to compare turtles with other familiar objects, such as fish and poultry, which may be bought either whole or dressed to suit the wishes of the buyer. The proprietors of some of the fish markets on the Mississippi (Muscatine, Iowa, and New Boston Ill.) and on the Illinois (Peoria), who have much experience weighing fish, since they buy them living from the fishermen and sell most of them dressed, were consulted in this regard, and their reports agreed very closely. Carp were reported to dress off about 30 per cent, or from 30 to 40 or 45 per cent, the higher percentages applying to the females full of roe, which is usually discarded. Buffalofish were reported to dress off somewhat less than carp. Catfish differ greatly, according to kind and condition, but dress off on the average 60 pounds to the 100. At the Fairport biological station two ripe male carp weighting 5 pounds 8 ounces were dressed. The head, scales, and entrails weighed 1 pound 3 ounces and the milt 8 ounces, leaving the weight of the dressed fish 3 pounds 12 ounces, a waste of 31.8 per cent. In looking through publications at hand devoted to poultry, under the subject of waste, cocks were reported to dress off 23.4 per cent, cockerels 26 per cent, hens 24.2 per cent, and pullets 25.8 per cent of the live weight. These wastes, of course, leave bones out of consideration. For fuller estimates and comparisons of the absolute amount of wastes of various fishes the reader is referred to a publication by Dr. W. O. Atwater, published as an appendix to the report of the United States Commissioner of Fisheries for 1880.[a] Unfortunately our data on the flesh of turtles are not in such a condition that they can be compared with the fish discussed in that article.

To one who has not watched the process it might appear that turtles would be difficult to dress. There is not nearly the labor involved in cleaning a snapper, however, that there is in plucking and dressing a chicken, and a novice would acquire the knack even more quickly with the reptile than with the fowl. The bones and joints are not so thoroughly ossified in the turtle and offer less resistance to the carver. Along with economical considerations it may be mentioned that one dealer remarked that "8 pounds of turtle will make soup for 50 people." Another phase of the subject which has to do with economy, but which is more closely related to the subject of cooking, will be discussed in that connection.

QUALITY OF FLESH.

The value of turtle flesh as a food and the extent to which it can be used as a substitute for other meats is a question to be solved

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[a] Atwater, W. O.: Report of progress of an investigation of the chemical composition and economic values of the fish and invertebrates used for food. Appendix D, Report of the Commissioner, U. S. Commission of Fish and Fisheries, for 1880, pp. 231–286. Washington.

by nutrition experts, by chemists who can compute its value in terms of calories, carbohydrates, proteins, digestibility, etc., and by experiments with "diet squads." This is fundamentally the most important question. Certain it is that the white and the deep-red, dressed meat as displayed in the fish markets is very attractive in appearance.

Scarcely less important, however, is the question of its gustatory qualities; for whatever gives zest to our necessary foods is by no means to be despised. References in literature to the relative merits of different species of turtle are rather few. Nash[a] says of the common soft-shelled turtle (*Amyda spinifera*): "The flesh of this turtle is considered a delicacy;" and of the snappers: "Their flesh is considered good and in some localities they are much sought after for making into soup."

The flavor of the snapper, like that of other sorts of game or meat, varies somewhat according to the habits of the individual animal and according to the method of preparation. Perhaps the best method of approach to this phase of the subject is a consideration of the habits of the turtle.

The snapper is very voracious, feeding on frogs, fishes, crayfish, young water birds, etc. It has been accused of catching and eating young ducks. Those examined at Lake Maxinkuckee, Ind., had been eating snails (*Vivipara contectoides*), and seven individuals examined at the Pekin (Ill.) market, caught at Fort Madison, Iowa, in June, 1918, contained solid masses of mud. Two had fragments of crayfish in the mud, one a piece of wood, and another the bones of a frog. A large one caught at Fairport, Iowa, a good deal earlier in the season had its stomach practically empty.

In the summer the snappers may be caught far from water, in grassy places, or in mudholes and puddles, and those caught in one place would doubtless differ in flavor from those caught in another. The turtle from the mud puddle would taste differently from the one caught on the grassy sward, just as beef from cattle and milk from cows grazing in a garlicky meadow differ from the products of a blue-grass pasture; just as the canvasback duck well fed on wild celery is the delight of epicures, while the same species feeding on the fetid Chara is as distasteful as any coot and the celery-fed coot excellent eating, and as a carp from a warm, muddy puddle is soft and rank, while one from a cool clear stream or pond is firm and excellent. Doubtless, the hibernating turtles taken from their winter quarters have approached a uniformity of flavor.

Still, taking the snapper by and large, it is sufficient to say that it has been exceedingly difficult to find, either spoken or printed, any words of disparagement. At Lake Maxinkuckee, it is true, the opinion was expressed that old snappers have a rank flavor and are tough; but the animals were there taken in summer from the beds of fetid Chara, which, when fed upon, will give even the choicest waterfowl a rank flavor. In addition to this, they naturally haunted the muddier parts of the lake, and, as has been said, subsisted on snails. Also, the delicious soft-shells were very abundant in that region, and the snapper would naturally suffer by comparison. In

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[a] Nash, C. W.: Manual of the vertebrates of Ontario. Published by Dept. of Education, Toronto. 1908.

most other places the snapper met with praise on every hand. Many had eaten no other kind of turtle but snapper, and it was liked in a great variety of ways.

In many respects, indeed, the eating of turtles may be well compared to the consumption of mushrooms. They are looked upon as a viand rather than as a food. Unknown or untried kinds are regarded with suspicion. The flesh of the box turtle is reported on pretty good authority to be unwholesome, and one man along the Mississippi asserted, but probably without reliable evidence, that "the striped turtles are poisonous." The general use of the snapper is much like that of the morel, or sponge mushroom. Persons who eat turtle at all eat this particular kind because they know it and are not so certain about the others. Those who had had experience with various sorts of turtles would always compare the snapper with other species. Some, but rather few, and these usually people fond of a pronounced gamy flavor, liked the snapper best. One man interviewed said: "The meat of the snapper is more like beef, while that of the soft-shell is more like chicken." An almost universal opinion was that the snapper contains several kinds of meat. One man said it contains 6 or 7 kinds; another, 7 to 9 kinds; and still another, 14 kinds.

The living snapper has a somewhat musky odor, but this may disappear or be diluted to a pleasant aroma by cooking, since no one complained of it. The meat of old snappers is said to be rather tough. One man said it was rendered stringy by cooking too long, and in making soup should be cooked only until the flesh left the bones. It may, indeed, be these two qualities—gaminess and toughness—that have made the snapper preeminently a soup turtle. Persons who discussed the matter of turtle soups asserted that "all turtle soups are really vegetable soups in which turtle takes the place of other kinds of meat." Some of these soups are highly spiced and flavored. One dealer reported that "restaurants are the only extensive users of turtles, and the snapper is used only for soup, which is not in much demand during hot weather." In the markets of the large cities there is little or no family buying of turtles, and the citizen who is accustomed to buying live chickens and either having them delivered or carrying them home would not think of doing the same with a snapper. Even the dressed meat is rarely bought for individual or family use. In the small river towns, however, there is more individual buying and a greater number of methods of cooking are in vogue. In one instance, at Pekin, Ill., when a half barrel of snappers, 10 in number, was received, 7 were immediately dressed for local sale. Usually, however, the people prefer soft-shells when they can get them.

THE ALLIGATOR SNAPPER.

The alligator snapper, *Macrochelys temmincki* (Harlan), which is found principally in the southern part of the United States, is similar in general habits to its smaller and more northern relative, the common snapper. It is especially abundant in the swamps of Louisiana, where an active fishery is carried on at certain seasons. It reaches an immense size, examples weighing as much as 219

pounds having been reported. Its sale is confined chiefly to southern markets. As it is too large to ship in barrels, it is prepared for shipment by drilling holes with a breast drill through the edge of the upper and lower shells on each side of the neck and feet, running wires through and fastening it so that the head and legs can not be protruded. The shell of one reported to have been taken at Hannibal, Mo., was seen by the senior author in St. Louis. The turtle was reported to have weighed 27 pounds.

THE FRESH-WATER TERRAPINS.

COMMERCIAL SIGNIFICANCE.

Within the Mississippi Basin the word "terrapin" is either a book name or a commercial term applied by market men to such of the hard-shelled turtles as find their way into the trade. Along the upper Mississippi and Illinois Rivers the only terrapin likely to be used is the Le Sueur terrapin, *Graptemys lesueurii* (Pls. III and IV). Along the upper Illinois a turtle, which from the description was supposed to be this, was referred to as the "Genetta." In the fish markets at Chicago lots of Le Sueur's terrapin and the elegant terrapin, *Pseudemys elegans* (Wied) (Pls. V and VI), were mixed together in barrels, no market distinction being made between them. Some of the *elegans* were said to be from Memphis, and they were called "Texas terrapin." In the turtle pen on the lower Illinois (Grafton) *elegans* was about as common as *lesueurii*, and was known as the "pond terrapin," the other species being the "river terrapin." At St. Louis the only terrapin seen at the opening of the turtle season in autumn was *elegans*. At Grafton *lesueurii* was the most highly esteemed of the two. Throughout the area under discussion there is another terrapin, the map turtle, *Graptemys geographica* (Le Sueur), so very similar to the Le Sueur terrapin that anyone but a specialist (and this includes both zoologist and fisherman) is likely to confuse them. The map turtle is probably as good as the others, but we saw none on the market. It apparently does not reach so large a size, however, and this may help explain its absence.

Exceedingly few terrapin are used even by the dwellers along the rivers, who are familiar with all sorts of aquatic food. This is probably due, not to their lack of excellence, but to the abundance and well-known qualities of the snappers and soft-shells, which have the additional advantage of larger size. The stimulus to the capture and sale of the terrapin, which is as yet rather feeble, comes from a demand in eastern cities, such as Philadelphia and Baltimore, where the diamond-back has been long known and esteemed and where the transition to other terrapin is easy. Along the Mississippi one man, an old fisherman who had at one time been a restaurant proprietor and famous for his cookery, said that they were most excellent eating. One of the fish dealers on the Illinois River said that terrapin is as good as the soft-shell, and each when fried is superior to chicken similarly prepared. In the Chicago market, unlike the snapper, which is sold by the pound, the terrapin are quoted by the individual or by the dozen. At one market they were quoted at from 25 to 30 cents apiece, and a fair sample weighed 2 pounds

and 11 ounces. Another dealer quoted them at 75 cents to $3 per dozen.

Along the Illinois River a little more was learned about the terrapin market. No actual fishing was in progress, but a turtle buyer from Philadelphia had visited the various fish markets and had distributed some information about its pecularities and market requirements. He stated that the terrapin were used as a substitute, or partial substitute, for diamond-back, and that for this purpose the males were not desired. What was wanted was the egg-bearing or "queen" terrapin. (At the Washington market in the autumn of 1917, when the first western—Le Sueur's—terrapin were coming on the market, it was learned that one of the "egg terrapin" was mixed with several diamond-back to make "diamond-back soup.") The river fishermen were unable to distinguish the sexes; but the Philadelphia buyer could do so, and readily picked out the "queens" from a lot of terrapin at hand, discarding the rest. During the summer of 1918 "queen" terrapin were being quoted at that place at $1 each. At St. Louis, in October, is was learned that the market men there distinguished the female of at least *Pseudemys elegans* by its much longer claws. There was no opportunity to verify this by dissection; but some of the turtles—a numerically small proportion of those at hand—had much longer and sharper claws than the others, and there was no marked intergradation in this respect. This may be a correlation with their habit of digging for the purpose of laying their eggs. The long-clawed terrapin, assumed to be females, also generally exhibited a different marking on the under side of the plastron. Late in the autumn (1918) a barrel of elegant terrapin, a few individuals of which possessed exceedingly long, sharp claws, was noted at Chicago.

Both at Chicago and St. Louis the market men reported that the only local buyers of terrapin were the Chinese, who are also buyers of the diamond-back shipped from the east. One of the proprietors of a fish market stated that the Chinese used the terrapin chiefly medicinally, "to clear the blood," and that by calling at a Chinese restaurant designated by him further information and a recipe could be secured. Upon visiting the place a very accommodating Chinese chef furnished the following information: "Turtles are good for internal troubles, for the blood, and especially for tuberculosis. They are cooked together with herbs imported from China and for which there is no English name. According to one recipe, the bones of the turtle are removed and the under part of the shell is boiled two or three hours with the skeleton of a duck. According to another, the meat is boiled in a double boiler with strong alcoholic wines, whisky, gin, etc." He added that he partakes of turtle in this manner only a few times in a year, when he feels in need of a tonic, stating that it makes him feel like a new man. Diamond-back terrapin was said to be the best turtle to use for this tonic, but, as it is very expensive, the hard-shell turtle, "Texas terrapin," is used as a substitute. Both from the remarkable similarity of the last given recipe to that of ordinary diamond-back-terrapin soup, and, from the statement of a native of China that the people of that country do not eat turtle, we are inclined to suspect that the use of terrapin is an American extension of the native bill of fare.

The most probable reason for the exceedingly limited use, one might almost say the nonuse, of the terrapin within the Mississippi Basin is the unfamiliarity with them. They rarely stray any distance from considerable bodies of water and are not often seen by the general population. To the frequenters of river and lake shores they are, however, the most commonly seen of turtles.

Other features that have prevented their coming into use are their relatively small size, 2 pounds being about the average, and the amount and hardness of shell, making the percentage of meat relatively small and difficult to get at. So long as there is a great abundance of other forms of game and fresh food the only reason for resorting to them would be the superior flavor of the flesh, and they would be sought after as luxuries rather than necessities. Their appeal would be to the taste rather than to the satisfaction of hunger. There is, of course, the deep-seated feeling that nothing common can be a luxury, as is indicated by the old contracts that servants should not be fed shad too frequently and by the fable about the farmer and crayfishes.

That the terrapin is of excellent flavor would appear from the testimony of those who have tried it and from the fact that it can be successfully substituted for the diamond-back. As a rule, it inhabits clean waters. The different species of terrapin differ in their food and feeding habits, and doubtless in their flavor, to a corresponding degree.

METHODS OF CAPTURE.

Because of their habits, the manner of the capture of the terrapin is entirely different from that of the snapper. They do not crowd together in hibernating places during the winter and can not, therefore, be taken in numbers during that season, as the snappers are. In the summer they are gregarious, crowding together in great numbers on projecting logs and banks. They can be easily taken in traps, a number and variety of which are known along the Illinois River. By simply sinking a box in a place full of snags and brush, a goodly number of terrapin will manage to drop in. A fish dealer reported that one man had a waterproof box sunk in water by weighting it with stones. He visited it daily, removing 30 to 40 turtles. Another form consisted simply of a box with an inclined board for a slide leading up to it. The turtles climbing up the slide to bask crowded the end ones into the box. A still more complicated form had the slide so placed on a pivot that if one or more turtles got beyond the pivot and overbalanced the lower end they were dumped into the box. The success with which an old sunken boat on a bar in Lake Maxinkuckee was observed to catch terrapin indicates the effectiveness of any of these devices. The gunwale of the boat would be crowded with the basking terrapin; and upon anyone's approach they would plump at once into the water, about half of them landing in the boat. The boys in the region, out of sport, caught 50 or 60 of the animals in one afternoon in this manner.

A method used in trapping the "slider," a species of terrapin in the southeastern part of the United States, doubtless would also prove efficacious. A projecting log is chosen and a heavily leaded

net placed entirely around it, except at the lower or entering end. The turtles climbing up on the log to bask keep pushing the foremost one off, and, if anyone approaches, all but one or a few at the lower or entering end of the log drop into the net. By this means great numbers can readily be taken.

SHIPMENT, STORAGE, AND MARKETING.

The shipment, storage, and marketing of the terrapin are the same as that of the snapper, except that, as has been said, practically all are sent to eastern markets. In the local markets they are sold by the individual or by the dozen instead of by weight.

THE SOFT-SHELL TURTLES.

Among the possible aquatic resources of the country an important place is occupied by the soft-shell turtles, of which there are two common species—the spiny, or common, soft-shell, *Amyda spinifera* (Le Sueur) (Pls. VII and VIII), and the smooth soft-shell, or leatherback, *Amyda mutica* (Le Sueur). These turtles are generally northern in their distribution. They are confined chiefly to the larger streams and lakes and are therefore rather unfamiliar objects to the general population. They never stray far from the water's edge and are very timid in disposition, taking to the water with exceeding swiftness when alarmed, so that even those who spend a great deal of time along rivers and lakes rarely get a very good view of uncaptured specimens. They are gregarious, assembling in considerable numbers on banks and sand bars.

COMMERCIAL SIGNIFICANCE.

The soft-shell turtles are seldom found in the markets. None was seen in the Washington market nor in Chicago, where it was reported that "they could not be given away, much less sold." And yet, where well known, the soft-shell is regarded as the most delicious of turtles. It is, indeed, a species of soft-shell turtle which is reared in Japan, much as the diamond-back terrapin is beginning to be raised in this country.

One reason for the absence or rarity of soft-shell turtles on the market is that they are too little known at the great market centers and too well known at the place of capture. No general demand has been created, and no special efforts are made to capture them. Numbers are incidentally caught by various forms of fishermen's gear, such as set lines, seines, and hoop nets, especially baited "fiddler nets" (the nets used to catch channel catfish). These incidentally caught turtles are not usually allowed to get beyond the fisheman who catches them; they are consumed mostly in the immediate locality where caught. In the small towns along the Mississippi and Illinois Rivers they are the favorite food turtles. The snappers are shipped to market and the soft-shells consumed locally. The dealers attribute their absence from the markets to several reasons. They do not stand shipment as well as other turtles, being of a more delicate nature. They are flatter and not so meaty as the

snapper; so there is more waste. The soft-shells, therefore, rank with those "home-consumption" delicacies, the famous honey banana, the emerald-gem muskmelon, and the fall pippin apple, which are too good for the market place and can not retain their original flavor after passing through the hands of the middlemen. The fish dealer at one of the towns visited shipped out a barrel of snappers, but when visited later it was found that he had a goodly number of soft-shells on hand. "They do not get beyond me," he explained.

The soft-shells are prized, not only for soup, but for frying; and for this purpose the younger individuals, weighing from 1 to 1½ pounds, are preferred. In making soup the shell may either be used or discarded.

The soft-shell loves the clear water over sandy bottoms and prefers a good current. Its principal food, to judge from a few specimens examined, consists of crayfishes. Both its habits and habitat are therefore conducive to an excellent flavor of flesh.

METHODS OF CAPTURE.

On account of their habits, the soft-shells can not be taken in quantities by the methods used for either the snapper or terrapin. They are gregarious, like the terrapin, but, as a general thing, they do not seek elevated positions in basking, any good sand bar proving satisfactory. They would not drop in numbers into boxes, and they do not "mud up" in large numbers, as do the snappers during the winter. They are rather hard to get in an ordinary seine. During the summer of 1907 several hundred were seen basking on one of the sand bars of the upper Mississippi not far below St. Paul. The sand bar was surrounded by a long net, with the expectation of bagging several barrels of turtles. These all took to the water and the net was drawn in. Only two turtles were obtained, the net having passed over the others, which had, no doubt, simply flattened down close to the bottom.

As previously stated, most of the soft-shells are captured incidentally on set lines or in hoop nets operated for fish. They can readily be caught in baited hoop nets, and one fisherman said that it was easier to get them, when desired, than it was to capture snappers. The nets must be visited at least every 12 hours, especially in warm weather, as the imprisoned turtles soon drown. Prof. Jacob Reighard in Ward and Whipple's "Fresh-water Biology," page 66, gives the following description of a turtle net:[a]

> Turtles are best taken in a turtle net, which is a form of fyke net. It should be of heavy twine and coarse mesh and, if it is desired to keep the turtles alive, should be modified as follows: The terminal section of the pot is made cylindrical or the whole pot may be made with square hoops. A circular opening is cut in the upper side of the terminal section of the pot and to this is attached the lower end of a cylinder of netting which extends to the water's surface. The upper end of this cylinder is attached to an opening cut in one side of a wooden box, provided on the opposite side with a hinged lid fastened with a hasp. The box is supported at the surface of the water on poles set in the bottom. When turtles reach the terminal section of the pot, they are able to

[a] Reighard, Jacob: Methods of collecting and photographing. Chap. III of Fresh-water Biology, by Henry B. Ward and George C. Whipple. John Wiley & Sons, New York, 1918.

enter the box through the cylinder of netting and are thereby saved from drowning, which would ensue if they could not reach the air. They may be removed through the lid at the convenience of the collector.

SHIPMENT.

In the upper Mississippi and in some of the glacial lakes in the northern part of our country the soft-shell is exceedingly abundant and if made use of would offer a considerable amount of meat to the inhabitants of those regions. The market men say that it can be beheaded and rough cleaned—that is, with just the viscera removed—and shipped on ice. In this condition it keeps as well as fish similarly treated. Frozen, they say, it remains in perfect condition and is as good when thawed as when fresh. Handled in this manner, it could, if there were a sufficient demand, furnish a considerable meat supply to a large area.

Taking the country at large, the turtles are much more scarce than formerly. From along the upper Illinois River comes the complaint that the turtles, especially appreciated there, are "becoming very scarce" or "practically exterminated" and that the local market demand is greater than the supply. This exhaustion is attributed to the draining of the feeding areas of the turtles and the building of levees. The State law of Illinois protects both turtles and terrapin of any size under a 7-inch shell. All that has saved the turtle to this day is probably the fact that it has remained more or less unappreciated.

ENEMIES OF TURTLES.

In spite of the various means with which nature has endowed the turtles for their welfare—the protecting shell of all of them; the timid disposition of the terrapin, which prevents them from wandering afar from safety and causes them to drop into the water at the first sign of alarm; the inconspicuous colors of most of them; the timidity and swiftness of the soft-shells; and the longevity of such as have passed the vicissitudes of early life—they are subject to many dangers and, on the whole, seem to be scarcely holding their own. A good many young appear to perish during the first winter. Muskrats kill a few of the smaller species, but do not appear to molest those of larger size. Leeches often accumulate on turtles in considerable numbers, and, though they may never directly kill them, they doubtless greatly lessen their vitality. In the Japanese breeding establishments old turtles devour their young, and this may occasionally happen in nature. Doubtless carnivorous animals often dig up the nests and devour the eggs, as one often finds eggs scattered about and evidence of digging where the turtles make their nests.

By far one of the most important enemies is man. Fishermen finding turtles in their nets or on hooks often kill and discard them, instead of either releasing or using them. Many persons make it a practice to rob turtle nests by the wholesale, either for so-called sport or to use their eggs for fish bait. By digging into the sand bars used for nesting places hundreds of eggs can be taken and destroyed in a short time. Many turtles, especially soft-shells, are drowned in hoop nets used by fishermen.

PREPARATION OF TURTLES FOR THE TABLE.

KILLING THE TURTLE.

Notwithstanding the formidable appearance offered by the shell, the killing and dressing of turtles is a comparatively easy matter, and the men at the fish markets soon become expert at it and can kill and clean them with surprising rapidity. The first step is to get the animal to protrude its head. In the case of the snapper, this is easily accomplished by presenting to its head a stick of suitable size for the reptile to snap. It takes tenacious hold, and the head can readily be pulled out. The heads of the other species may be made to protrude by applying pressure, as with the foot, to the back or upper part of the shell. After the neck is well stretched out the turtle can readily be decapitated. At fish markets, where many turtles are dressed, the cleaners usually have a killing plank with a sharpened spike driven through at an angle, and the spike is thrust through the chin during the process of stretching.

Once beheaded, a sharp knife is run around the edges of the skin where it joins the shell and the skin pulled back over the legs to the feet, which are then disjointed. The lower part of the shell or plastron is then removed by cutting through the bridges which join the upper and lower shells, cutting close to the lower part of the shell. With snappers and soft-shells, in which the bridges are rather soft and cartilaginous, this can be done with a sharp knife. With the terrapin the bridge may be cut with a hatchet or saw. Having cut the bridges, the plastron or under shell may be readily removed by inserting a sharp knife just under it and lifting it off. This done, the entrails may be extracted with very little trouble, and the four quarters easily taken out from the carapace or upper shell. If one wishes to save the tenderloin in the upper part or "ceiling" of the carapace, the ribs may be cut with a hatchet. To the reader this may appear to be a lengthy and complicated process; but, as stated above, it is a simpler process than killing, plucking, and dressing a chicken.

A visit to a place where turtles are being dressed by professionals would prove very instructive. It need hardly be said that each has his own method as regards the smaller details. Some cut off the feet before skinning; others skin down to the feet and then disjoint. Some even cut off the feet before decapitation, but this is unnecessarily cruel. The smaller turtles and terrapin are often killed by dropping the living animal into boiling water just as lobsters and crayfishes are killed. This is a convenient method and not especially cruel, as death is practically instantaneous. With a large kettle the same method might be used for the soft-shell and snapper.

RECIPES.

Doubtless one reason for the general nonuse of turtles for food is the lack of knowledge as to just how to prepare them for the table and the lack of experience with turtles properly cooked. To meet this deficiency, the following recipes, which have been obtained from various available sources, are offered. A few have been gleaned from cookbooks, but most of them have been procured from per-

sons noted locally for their preparation of turtles. Special thanks are due to Henry Lemm, of Pekin, Ill., and to Mrs. Saunders, of the Saunders Fish Market, St. Louis, Mo., for choice recipes.

SOUPS.

These recipes apply especially to the snapper, which is the great soup turtle of the Mississippi Basin. They could, doubtless, be applied to terrapin and soft-shell also, as they are as good for soups as the snapper.

In making soups, cook the turtle only until the bones leave the flesh. Many cook too long, which makes the flesh stringy.

1. *Turtle soup.*—A favorite way to cook snapper is to make the soup like old-fashioned beef soup, with any assortment of vegetables desired, with the turtle meat cut up into small pieces.

2. *Turtle soup*—Make up a soup stock, without vegetables, but add egg.

3. *Turtle chowder.*—One-half pound turtle meat, 2 medium-sized potatoes, 3 onions, 3 carrots, any other vegetables wanted, as parsley, all diced into the pot; add ¼ pound of salt pork diced, 1 teaspoonful pepper, 1 level teaspoonful of butter, and cook about 2 hours over a slow fire. This is fine, a regular turtle chowder. With soft-shell turtle cut up the shell also, and cook for 4 hours.

4. *Soft-shell turtle soup.*—Use turtle meat same as for beef soup, adding a slice of bacon and onion to modify the flavor. (Soft-shell turtle meat is also good with noodles.)

5. *Turtle soup à la creole.*—This is the ancient recipe for turtle soup, and it is safe to say that when once eaten after this delightful way no other will seem quite so savory. Cut the turtle meat into small pieces. Let it brown in a pot with a little lard, cut up several onions, a slice of ham, and a little garlic, and stir and mix with the turtle meat. Then let the mixture brown well. Put in some flour and mix, pour a quantity of the soup stock into the pot, let it cool, and add a knee joint of veal. Let it simmer for an hour, then put in some thyme, laurel leaf, parsley, shallots, and when everything is cooked add more parsley and a couple of slices of lemon chopped fine. Just before serving add a wineglassful of Madeira wine, or, in lieu of this, ⅔ that amount of lemon juice.

6. *Terrapin soup.*—Use the meat and eggs from 1 terrapin, put into a stewpan with 2 tablespoonfuls of butter, and let it simmer until quite hot throughout, keeping the pan closely covered. Serve with the following sauce: 1 beaten egg yolk flavored with nutmeg and mace, ½ cup currant jelly, 1 pinch of cayenne, salt to taste, 1 tablespoonful of butter.

FRIED TURTLE.

Although the turtles generally preferred for frying are medium-sized soft-shells weighing from 1½ to 3 pounds, many like fried snapper. For frying, the younger and more tender snappers are to be preferred, although the older ones can be used by cooking correspondingly longer.

7. *Fried turtle.*—Cut the turtle meat into small pieces, add salt and pepper, roll in flour, and fry in one-half lard and one-half butter until brown, then add a little water, cover up, and steam until done (about ½ hour).

8. *Fried turtle.*—Fry as above; when browned add some catsup, a few mixed spices, a glass of wine, or, in lieu of this, 2 tablespoonfuls of vinegar and a little water; cover, and steam until done (about ½ hour).

9. *Fried turtle.*—Some cooks prefer to fry dry, without steam; in this case one must cook slowly, and of course old turtles must be cooked longer than young ones.

10. *Fried turtle.*—Simply parboil the turtle meat and fry in butter.

11. *Fried turtle.*—Put the turtle meat into salt water for a short time, remove and wipe dry, sprinkle with corn meal, and fry in hot grease, or use butter, salt, and pepper, and thicken with barley. (The person who furnished this recipe generally preferred snapper to other turtles, and had this species in mind.)

12. *Fried snapper.*—Put the turtle meat into salt water overnight, take out, wipe dry, sprinkle with flour, and fry in plenty of grease. Fry slowly until brown. This is said to be better than fried chicken. For this old turtles are said to be as good as young.

MISCELLANEOUS.

The following recipes were obtained at St. Louis and apply to the native turtles used there. They were meant to apply especially to the snapper; it is believed, however, that they could be applied to the more delicate soft-shell, where procurable, with even better results.

13. *Steamed turtle.*—Take fresh turtle meat, fill with black pepper and a bit of butter, steam until the flesh separates from the bones, then add black sauce (the soy-bean sauce to be found in Chinese restaurants) or Worcestershire sauce.

14. *Turtle cutlet.*—Take lean turtle meat, pound until like hamburger steak, dip into egg, roll in meal, and fry in hot fat. This tastes like veal cutlet.

15. *Simmered turtle.*—Take 1 pound turtle meat, wash, cut into cubes, brown in fat (lard or butter) with 1 large or 2 medium-sized onions, simmer until tender, add Chili pepper while simmering. To serve, pour over boiled rice.

16. *Curry of turtle.*—Take 1 pound of turtle meat, brown as above, with 1 large or 2 medium-sized onions. Put into the pot 1 medium-sized potato, 1 carrot, the onions which have been cooked with the turtle, a small piece of parsley, ½ teaspoonful of pepper, 1 teaspoonful of salt, and ½ teaspoonful of curry powder. Add the browned turtle meat to the mixture in the pot and let simmer until tender. Make molds by hollowing out cups of boiled rice and serve in the molds. This tastes like curry of chicken or curry of veal.

17. *Turtle rivola.*—(*a*) One-half pound turtle meat, best chopped through a food chopper, add 2 onions, cook until tender, add ¼ pound of cheese and salt and pepper.

(*b*) Take 1 cup flour, 1 egg, ¼ teaspoonful salt, make a thick batter, roll out thin into a sheet of noodle dough, and cut into 2-inch dice.

(*c*) Take 1 spoonful of minced turtle meat, lay on the diced noodle dough, fold over 3 corners and inclose the meat, cook like noodles in the water that the turtle meat was cooked in, to which a spoonful of butter has been added.

18. *Turtle sausage.*—Cook 2 pounds of turtle meat until tender, run through a food chopper, add 2 eggs, drop into hot fat or fry right off the spoon until brown.

While the following recipe was originally intended to apply to the diamond-back terrapin, it would doubtless serve very well for the fresh-water species, and possibly for snapper or soft-shell turtle also:

19. *Stewed terrapin with cream.*[a]—Place in a saucepan 2 tablespoonfuls of butter and 1 of rice flour, stir over a fire until it bubbles, then stir in a pint of thin cream, 1 tablespoonful salt, ½ tablespoonful white pepper, ¼ tablespoonful grated nutmeg, and a very small pinch of cayenne, next put in 1 pint of terrapin meat, and stir it all until scalding hot. Move saucepan to back part of stove, where contents will keep hot, but not boil, then stir in 4 well-beaten yolks of eggs. Do not boil, but pour immediately into tureen containing 1 tablespoonful lemon juice. Serve hot.

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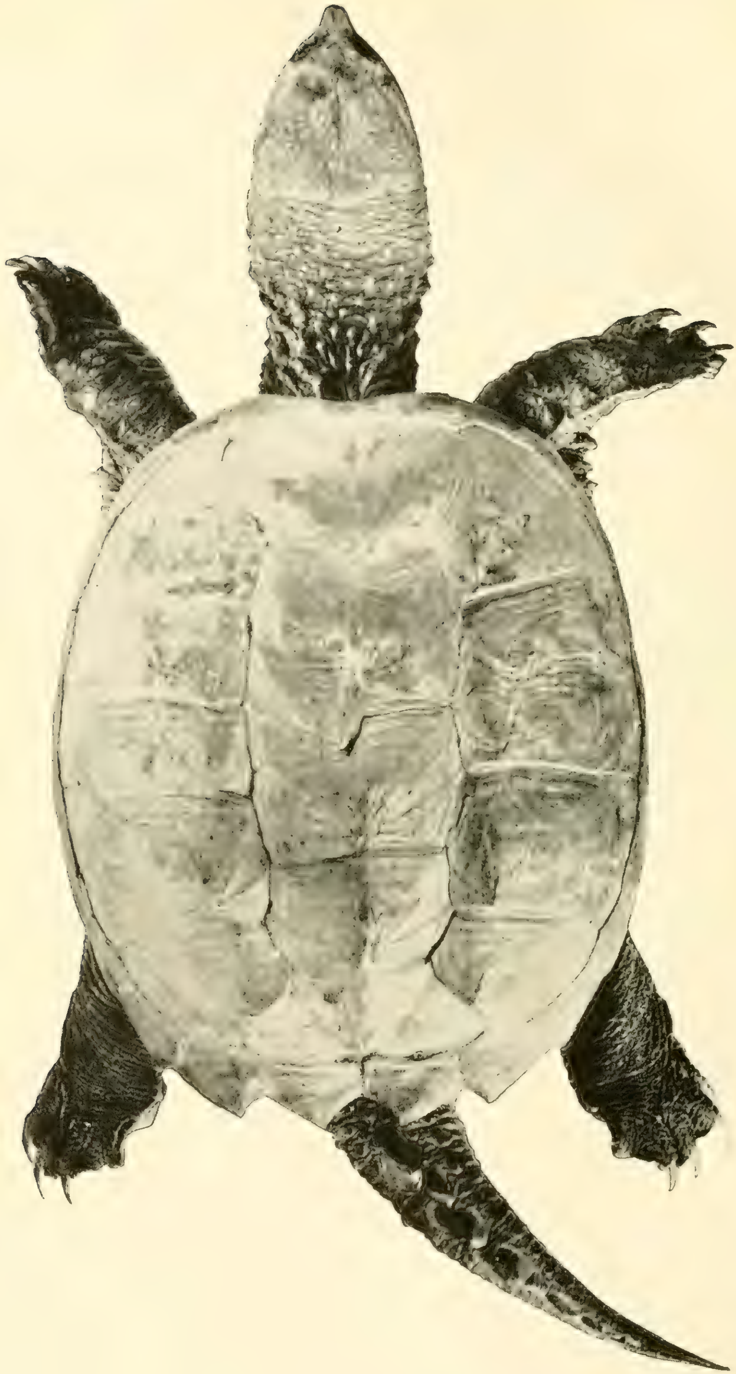
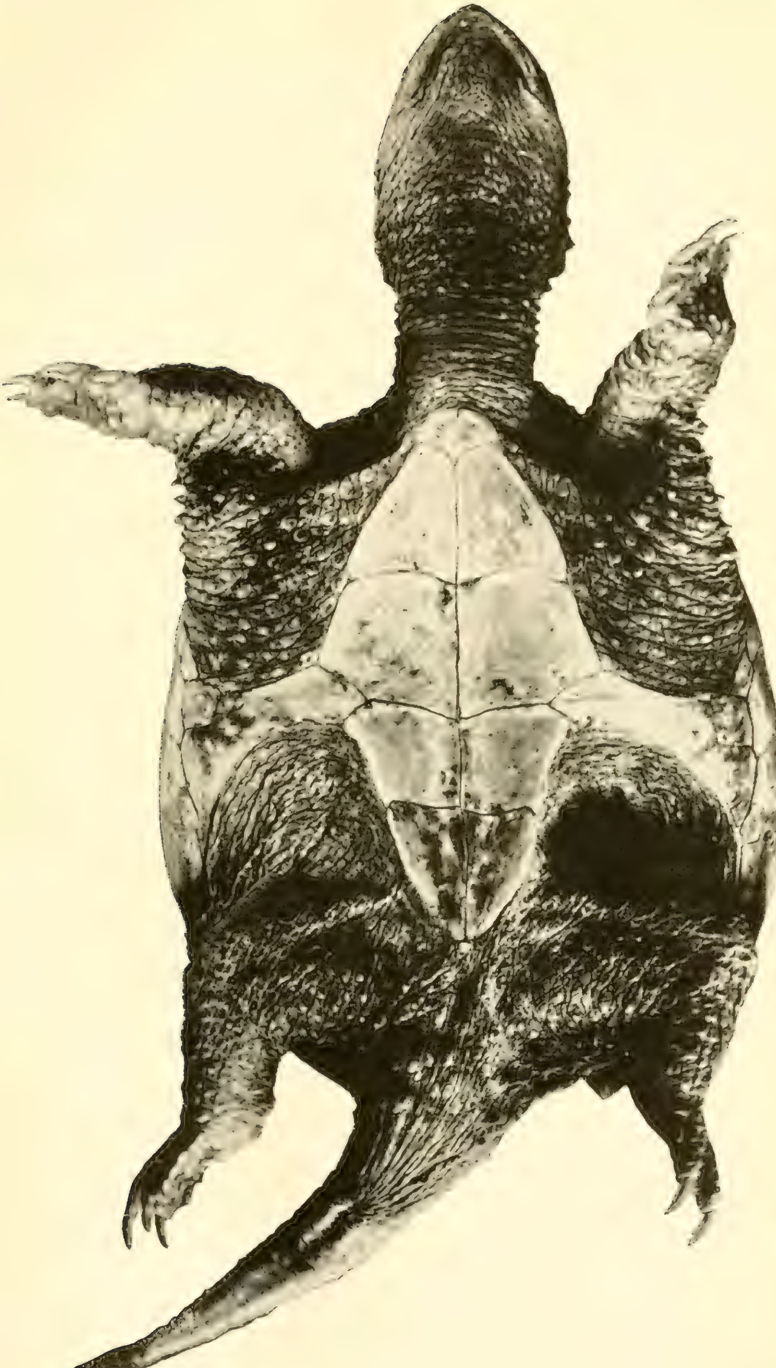
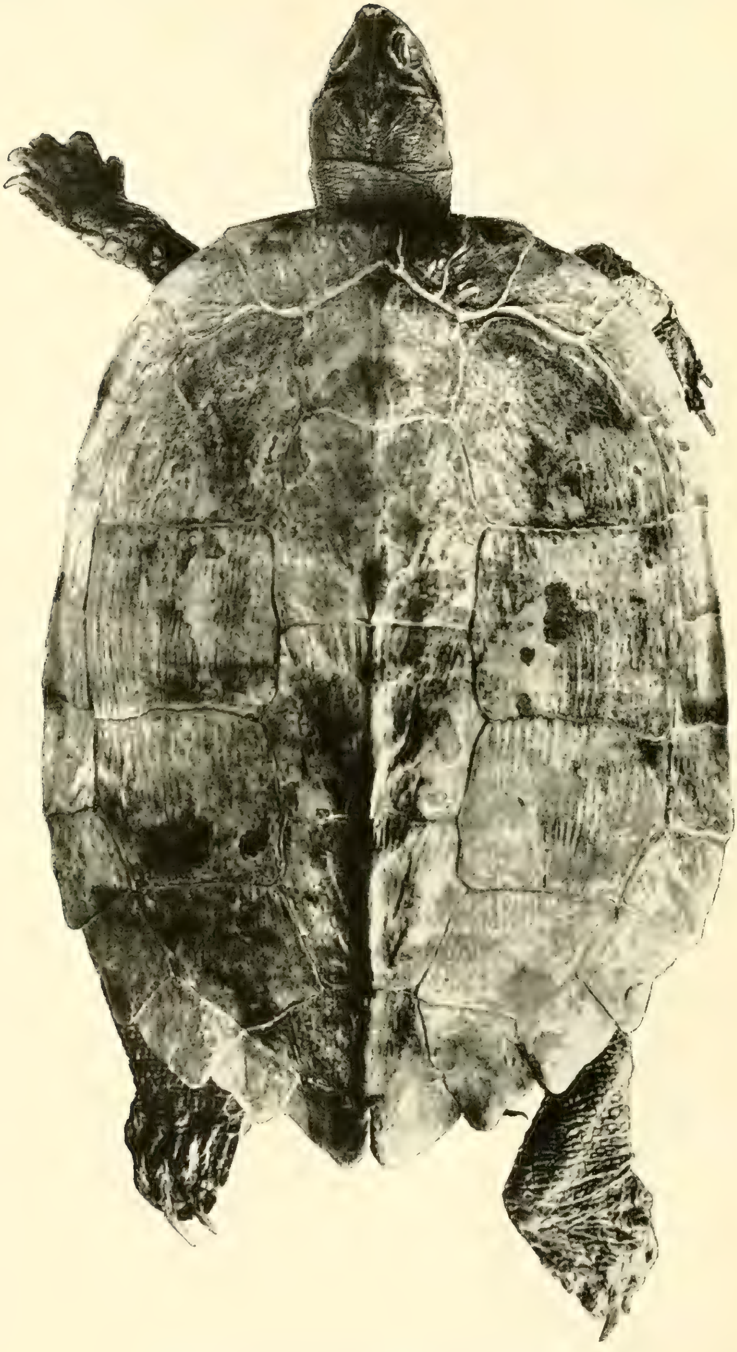
[a] From the "White House Cook Book."



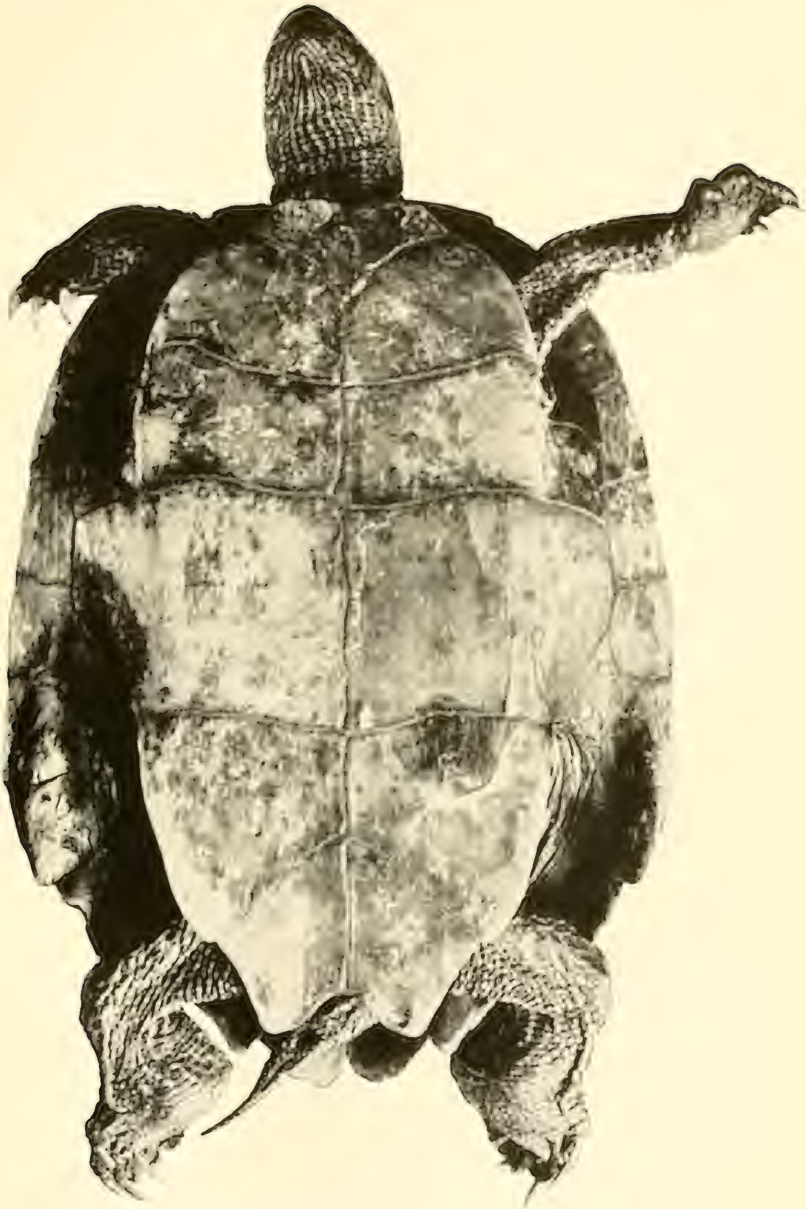
SNAPPING TURTLE, CHELYDRA SERPENTINA (LINNAEUS).



SNAPPING TURTLE, CHELYDRA SERPENTINA (LINNAEUS).



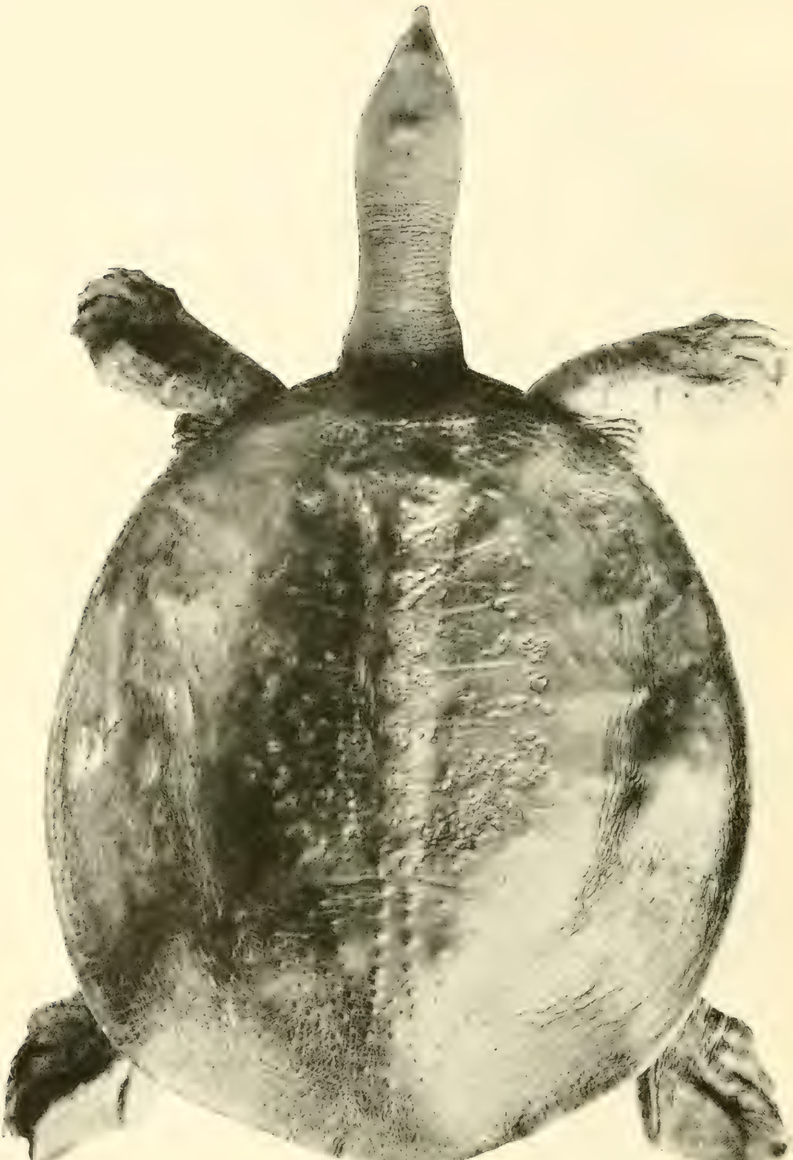
LE SUEUR TERRAPIN, GRAPTEMYS LESUEURII.



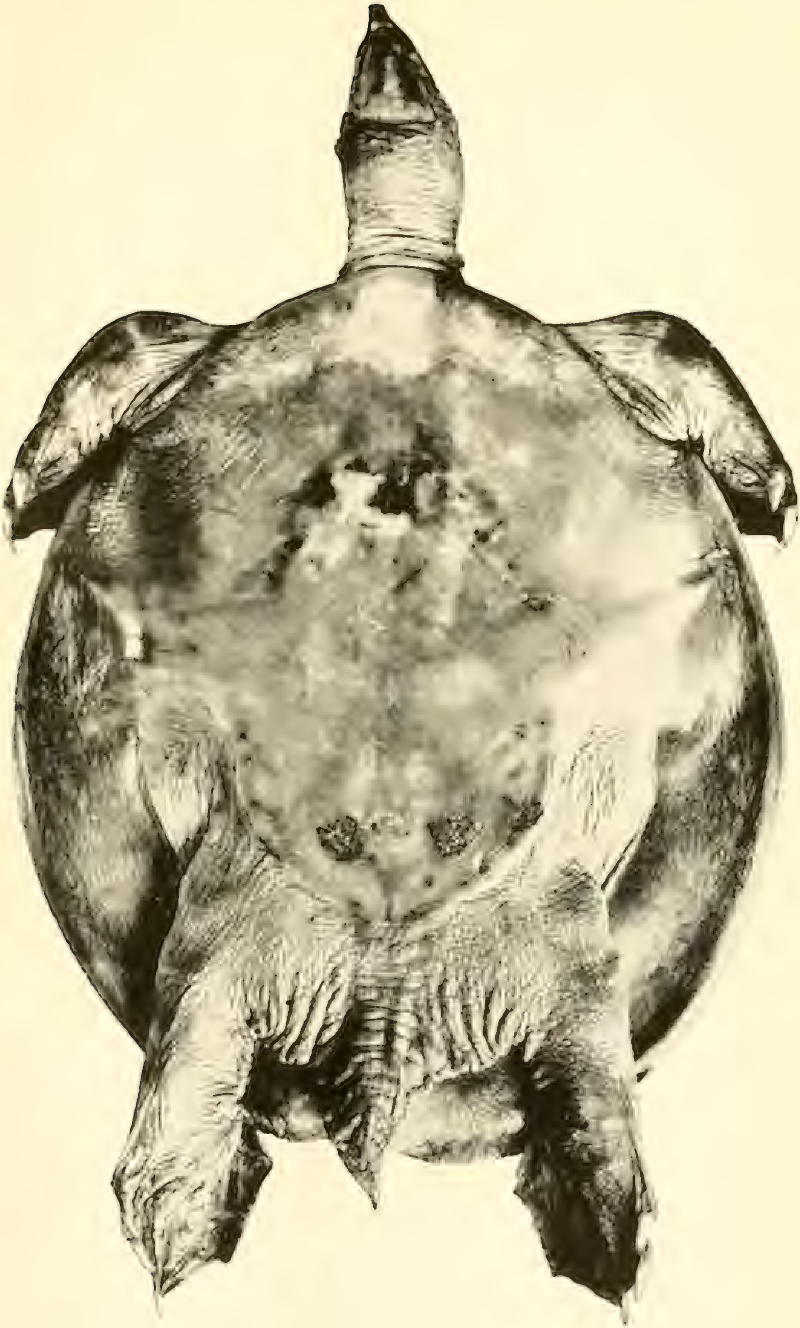
LE SUEUR TERRAPIN, GRAPTEMYS LESUEURII.

ELEGANT TERRAPIN, PSEUDEMYS ELEGANS.

ELEGANT TERRAPIN, PSEUDEMYS ELEGANS.



SOFT-SHELL TURTLE, AMYDA SPINIFERA.



SOFT-SHELL TURTLE, AMYDA SPINIFERA.

THE OYSTER AND THE OYSTER INDUSTRY OF THE ATLANTIC AND GULF COASTS

By E. P. CHURCHILL, Jr.
Assistant, U. S. Bureau of Fisheries

Appendix VIII to the Report of the U. S. Commissioner of Fisheries for 1919

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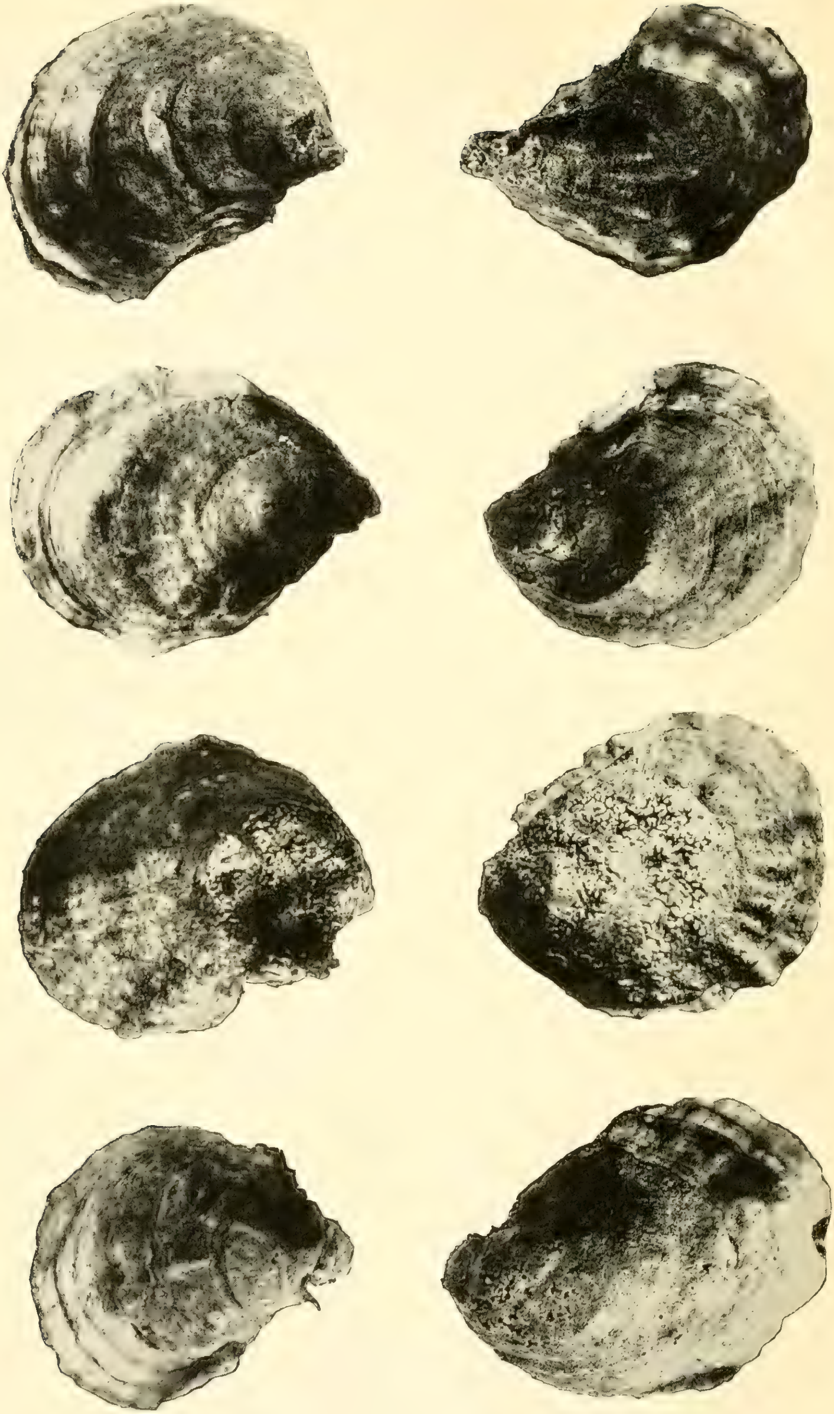


BLUE POINTS, FROM NEAR BLUE POINT, LONG ISLAND.

About one-half natural size.

THE OYSTER AND THE OYSTER INDUSTRY OF THE ATLANTIC AND GULF COASTS.

By E. P. Churchill, Jr., *Assistant, U. S. Bureau of Fisheries.*

INTRODUCTION.

The taking of oysters constitutes the most valuable fishery of the United States and one of the most valuable in the world. The annual yield in this country is about 30,000,000 bushels, with a return to the fishermen of nearly $15,000,000. At least 99 per cent of the oysters of the United States are produced on the Atlantic and Gulf coasts, as shown by the following table:

Oyster Product of the United States.

[From statistics collected by the U. S. Bureau of Fisheries.]

Region.	Private grounds.		Public grounds.		Total.	
	Bushels.	*Value.*	*Bushels.*	*Value.*	*Bushels.*	*Value.*
New England States (1910)	5,549,318	$3,439,450	92,703	$157,584	5,942,021	$3,597,034
Middle Atlantic States (1911-12)	7,090,883	5,204,124	11,815,193	4,059,432	18,906,076	9,263,556
South Atlantic States (1910)	456,194	171,298	1,244,804	192,886	1,700,998	364,184
Gulf States (1918)	1,227,969	528,123	2,165,526	578,597	3,393,495	1,006,720
Pacific Coast States (1915)	152,560	548,005	3,544	8,619	156,104	556,624
Total	14,476,924	9,891,000	15,301,770	4,997,118	30,098,694	14,788,118

The report of the Commissioner of Fisheries for 1913 stated that the total number of persons engaged in the oyster industry of the United States was 67,257, the yearly wages paid amounting to $10,876,801, and that the investment in vessels, apparatus, property, etc., was over $17,000,000.[a]

GEOGRAPHICAL DISTRIBUTION.

On the eastern and southern coasts of the United States oysters are found from Wellfleet, Mass., on the inner shore of Cape Cod, to the southern extremity of Texas. The industry on these coasts is bounded by the same limits. Although in past times oysters were found in Maine and New Hampshire, practically none occurs there now, and these two coastal States alone have no oyster industry.

The location of the main oyster beds in each State concerned and the principal towns in which the industry is centered are cited below. The Atlantic and Gulf coast is not lined with a solid bed of oysters along its entire length. Oysters are not found in the open sea, but in coves, bays, estuaries, and mouths of rivers—in a word, in partially

[a] Report U. S. Commissioner of Fisheries, 1913, p. 40. Washington.

inclosed waters rendered brackish by drainage from the land. This fact will become more apparent during the reading of the ensuing paragraphs.

MASSACHUSETTS.

The main oyster beds are in Wellfleet Harbor, in the waters in the vicinity of Chatham, in Cotuit Harbor, and in Poponesset Bay. Some oysters are also taken from Centerville Harbor and from the mouths of Wareham and Taunton Rivers. The principal towns concerned are Wellfleet, Chatham, Cotuit, and Falmouth. The oysters are shipped in the shell or shucked, on ice.

RHODE ISLAND.

The main oyster beds are in Narragansett Bay, the industry being centered at Providence, where there are about a half dozen oyster-houses. The oysters are shipped in the shell or shucked, on ice.

CONNECTICUT.

Although oysters are found along practically the entire coast, the principal beds are inside Thimble Islands, in New Haven Harbor, Milford Bay, Bridgeport Harbor, South Norwalk Harbor, around Great Captains Island, and in the deeper water offshore from these places. All the oysters are shipped in the shell or shucked, on ice. There are 6 oyster houses at South Norwalk, 16 at New Haven, and 1 each at Milford, Stony Creek, Guilford, and New London.

NEW YORK.

The oyster beds of New York are in the waters around Long Island. The oysters are shipped in the shell or shucked, on ice. There are 4 oyster houses at Greenport, 1 at Suffolk, and 2 at Northport, on the north side of the island. On the south, West Sayville and Patchogue are the centers of the oyster trade, there being extensive beds in Great South Bay. New York City is the great center of the oyster trade of the State.

NEW JERSEY.

The main oyster beds are in Raritan, Barnegat, and Great Bay, on the eastern coast, the oysters being handled chiefly at Tuckerton and Keysport; and in Delaware Bay, on the west, especially in Maurice Cove and vicinity. The oysters from this region are shipped from Bivalve, where there are several houses handling oysters in the shell or shucked, on ice.

DELAWARE.

The oyster beds are in Delaware Bay, mainly from Bombay Hook to below the mouth of St. James Creek. Most of the oysters are marketed through Bivalve, N. J.

MARYLAND.

The principal oyster beds are in the Chesapeake Bay, there being some, however, in Chincoteague Bay and Potomac River. The number of oyster houses at the main centers of trade are as follows: Crisfield, 40; Baltimore, 28 (15 being oyster canneries); Cambridge, 25; Oxford, 15; Annapolis, 13; Tilghman, 8; and St. Michaels, 6. There are about 160 oyster houses in all in the State. Baltimore is the only city in the State where oysters are steamed and canned, and is the most northerly point on the coast where this process is employed.

VIRGINIA.

The waters covering the main oyster beds of the State are those of Chesapeake Bay, Chincoteague Bay, and the eastern coast of Accomac and Northampton Counties, and the Potomac, Rappahannock, York, and James Rivers. There are about 35 oyster houses, 19 at Norfolk and Portsmouth, 2 at Hampton, 1 at Phoebus, 3 at West Point, 2 at Urbanna, and others scattered about in Northampton, Middlesex, Lancaster, and Accomac Counties. The oysters are shipped in the shell or shucked, on ice, none being canned. One firm prepares an oyster powder from the dried meats.

NORTH CAROLINA.

Four-fifths of the oyster beds of this State are in Pamlico Sound. There is one cannery at each of the following points: Beaufort, Morehead City, Washington, Vandimere, Davis, Bay River, and Sea Level. There is one shucking house, or "raw house," as such a place is termed in the South to distinguish it from a cannery, at Newbern and several at Wilmington.

SOUTH CAROLINA.

Most of the oyster beds are in St. Helena and Port Royal Sounds near the southern extremity of the coast. There are five canneries at Charleston and six at Beaufort, besides two or three at smaller cities.

GEORGIA.

The oyster beds are found along the entire coast line, especially in St. Catherines, Sapelo, Do Boy, Altamaha, St. Simons, St. Andrews, and Cumberland Sounds. There are 18 canneries in the State—four at Savannah, and the rest scattered along the coast. There are five wholesale dealers in raw oysters, besides several retailers at Savannah, Brunswick, and other points.

FLORIDA.

The principal oyster industry of the State is located at Apalachicola, where there are four canneries and nearly a dozen raw houses, the oysters coming from Apalachicola Bay and contiguous waters. There is a small oyster business at Carabelle and some beds at Cedar Keys. A few oysters are canned at Fernandina, on the east coast. There is a small local oyster business at other points in the State.

ALABAMA.

The oysters are found in the lower part of Mobile Bay and the east end of Mississippi Sound. There are 13 dealers in oysters in Mobile, but most of the oysters are opened or reshipped in the shell at Bayou Labatre and small adjacent points on the Mississippi Sound. The only oyster cannery in the State is located at Bayou Labatre.

MISSISSIPPI.

The principal oyster beds in this State are in Mississippi Sound, but 90 per cent of the oysters opened in the State are brought from Louisiana waters, especially from St. Bernard Parish. At Biloxi there are 12 canneries and 6 raw houses, the only city having a larger number of canneries being Baltimore, Md., which has 15. The following Mississippi cities have one cannery and one or two raw houses each: Gulfport, Pass Christian, Bay St. Louis, and Ocean Springs.

LOUISIANA.

The principal oyster beds are in the waters on the east of St. Bernard Parish, although important beds are found on the coast of Terrebonne and Plaquemines Parishes, and others are being developed to the westward. As a result of experiments conducted by the U. S. Bureau of Fisheries between 1906 and 1909, valuable oyster beds were established in Barataria Bay. These were subsequently broken up by a hurricane and the oysters washed about to different parts of the bay. From the natural propagation of the oysters so scattered several beds developed which have grown to be of considerable value. There are about 24 wholesale oyster dealers in New Orleans. One cannery is located near New Orleans, two farther down the river, two or three at Houma in Terrebonne Parish, and a new one is just starting at Franklin.

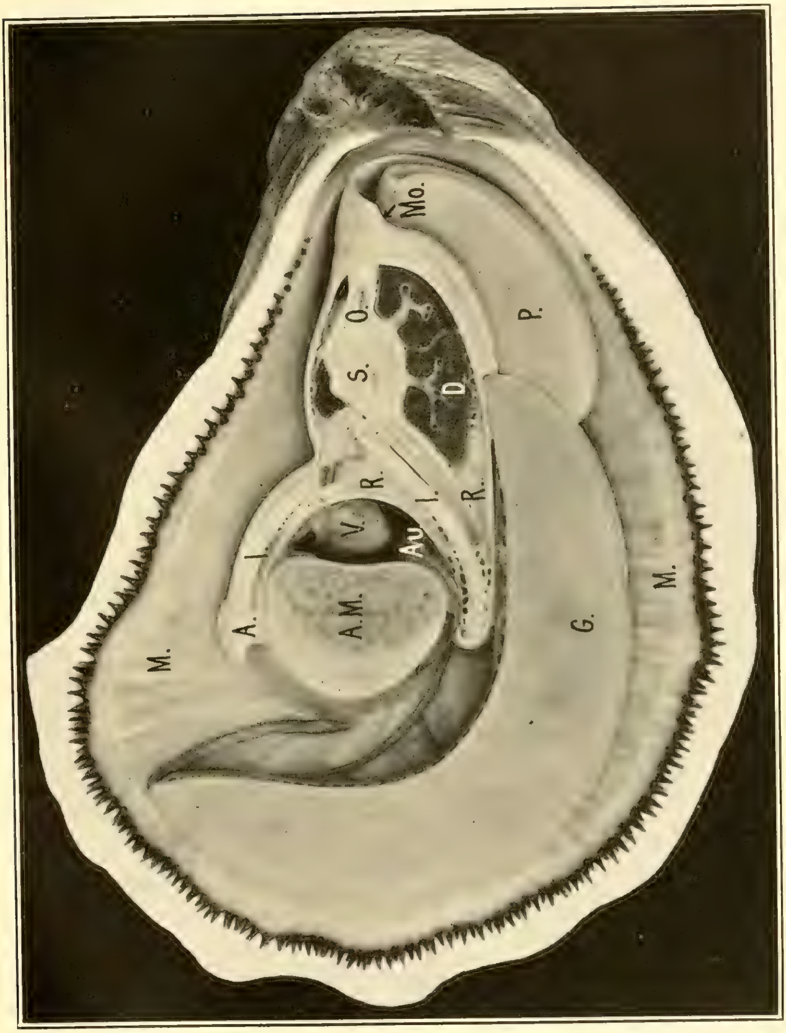
TEXAS.

The principal oyster beds of this State are in Galveston, West, Matagorda, Lavaca, Espiritu Santo, Aransas, Mesquite, and Corpus Christi Bays. There are from two to six oyster-shucking houses at Corpus Christi, Port Aransas, Rockport, Port O'Connor, Port Lavaca, Seadrift, Palacios, Matagorda, and Galveston. There are no oyster canneries in this State.

OUTPUT OF VARIOUS REGIONS.

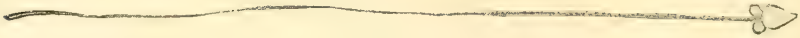
Chesapeake Bay produces more oysters than any other body of water in the world.[a] Some notion of the size of the industry there may be gained from Plate XVIII, figure 1, showing the oyster fleet operating out of Cambridge, Md., which is only one of the several large oyster centers on this bay. Virginia and Maryland, within whose borders Chesapeake Bay is embraced, lead the United States in oyster production with over 5,000,000 bushels each annually.[b]

[a] Smith, H. M. Oysters: The World's Most Valuable Water Crop. National Geographic Magazine, March, 1913, p. 261. Washington.
[b] Report, U. S. Commissioner of Fisheries, 1913, p. 41. Washington.



OYSTER WITH RIGHT SHELL AND MANTLE REMOVED.

A., anus; A. M., adductor muscle; Au., auricle of heart; D., digestive gland or liver; G., gills; I., intestine; M., mantle; Mo., mouth; O., oesophagus; P., palps; R., reproductive organ; S., stomach; V., ventricle of heart. (Photo from American Museum of Natural History.)



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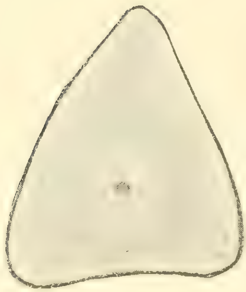

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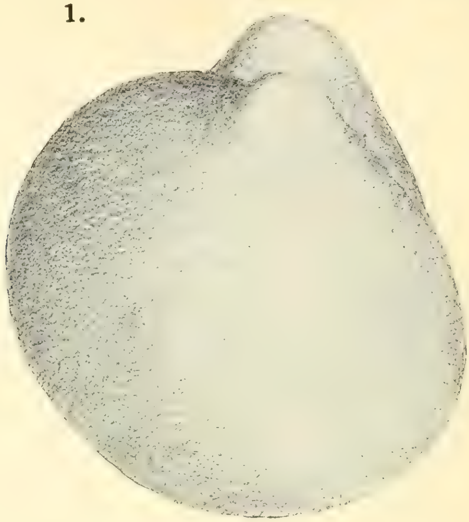

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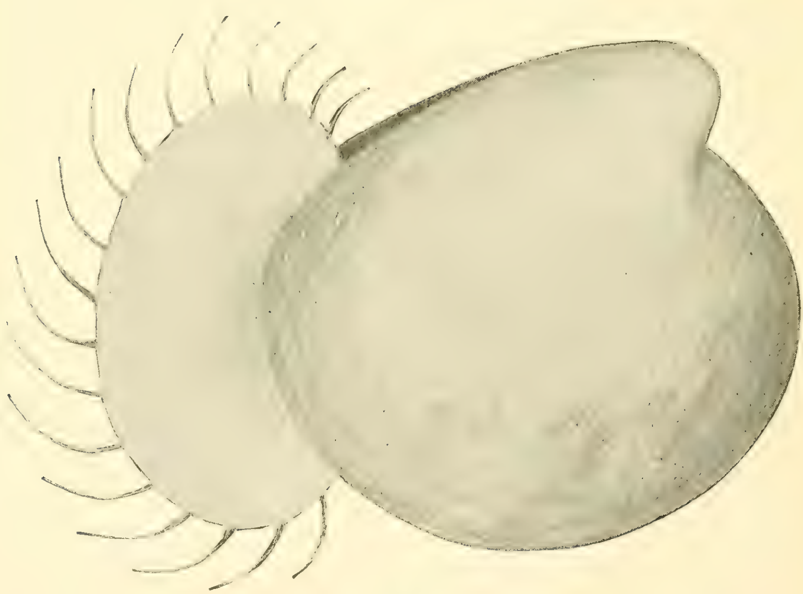

4.

FIG. 1.—SPERMATOZOON OF MALE OYSTER. Magnified 1,700 diameters. (After Stafford.)
FIG. 2.—OYSTER EGG. Magnified 600 diameters.
FIG. 3.—FREE-SWIMMING LARVA OF OYSTER, ABOUT 10 DAYS OLD. Magnified 300 diameters.
FIG. 4.—FREE-SWIMMING OYSTER LARVA WITH VELUM, OR SWIMMING ORGAN EXTENDED. Magnified 300 diameters.
(Figs. 2, 3, and 4 drawn by J. S. Gutsell.)

Connecticut is third with over 4,000,000 bushels. Rhode Island, New York, New Jersey, and Louisiana produce over 1,000,000 bushels annually.

DESCRIPTION AND ANATOMY.[a]

CLASSIFICATION.

The oyster of commerce in the United States, with the exception of certain parts of the Pacific coast, is the so-called "eastern oyster," belonging to the species *Ostrea virginica*, Gmelin. It is a member of the group of molluscs popularly known as bivalves, since it has two valves, or shells, which are joined at the narrower ends by a hinge.

EXTERNAL APPEARANCE.

The figures in Plates I, XX, and XXI, though reduced in size, give an idea of the usual shape and appearance of the oyster. The average length of the shells of the marketable size is about 5 inches. Oysters, however, may grow to much greater dimensions, and under certain conditions of growth, such as crowding or development on a mud bottom, are forced into various distorted or elongated shapes.

The shell of the adult oyster varies greatly in thickness, ranging in extreme cases from somewhat less than one-fourth inch to an inch and one-fourth. The usual thickness is from one-fourth to three-eighths inch, decreasing to paperlike thinness on the margins of a rapidly growing shell.

The exterior is marked by laminations and more or less concentric lines of growth; it is often covered by a yellowish cuticle, but is sometimes white and flinty in appearance. The inside of the shell is generally white, somewhat tinged with purple near the margins, and with a more or less pearly luster. The muscular impression is generally nearer to the posterior margin than to the hinge; it is a well-defined scar, kidney-shaped in specimens of ordinary size, but becoming more elongate in very large individuals; in young specimens it is pale, but it afterwards becomes purple or almost black. The left, or lower, valve is deeply concave within, the upper valve being flat or, usually, slightly concave. The animal portions are large, nearly filling the shell, and the mantle border is comparatively narrow.[b]

ANATOMICAL FEATURES.

The two valves of the shell of the oyster are held together at the hinge by a dark-colored elastic ligament so placed that it tends to throw the free ends of the valves slightly apart when the large muscle of the oyster is cut or relaxed. The main structures of interest making up the body of the oyster are shown in Plate II and in text figure 1. Plate II represents an oyster lying in the left valve, which is deeper than the right, and more cup-shaped. This is also nearly always the valve by which the oyster is attached to rocks, etc. The flatter right valve is represented as having been removed. The narrow part of the oyster is the anterior or front end, the mouth being located in that region. The broad part is the posterior or rear end. The back or dorsal side is at the top of the picture and the ventral or under side below. The oyster, however, being attached by its left side, may rest in the water in any conceivable position, depending on the surface to which it has fastened itself.

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[a] The brief account of the anatomy and life history of the oyster is based chiefly on the researches of Brooks (1895), Julius Nelson (1888–1893 and 1900–1915), and Stafford (1913).

[b] Moore, H. F. (1897, p. 266.)

Each valve or shell is lined with a thin membrane called the mantle, fringed on the edge and attached to the shell over nearly all its expanse, but free along the margin. The right mantle has been removed with the shell in Plate II. In about the center of the body is the large adductor muscle, by the contraction of which the oyster closes its shell. As stated above, when this muscle is relaxed or cut, the ligament in the hinge forces the valves apart. The main body of the oyster lies between the right and left sides of the mantle and is attached to it and the adductor muscle. It will thus be seen that the oyster is held to the shell by the mantle and the muscle.

In Plate II part of the body wall is represented as having been removed with the right side of the mantle, thus exposing to view the liver or digestive gland and the œsophagus or gullet leading from the mouth to the stomach, which opens into the intestine. This extends downward and backward beneath the muscle, then curves sharply and runs forward on the left of the stomach to the œsophagus, where it again turns to the rear and extends backward to the vent or anus above the muscle.

In a thin-walled sac, the pericardium, immediately in front of the muscle, lies the real heart of the oyster. (The adductor muscle is often erroneously referred to as the "heart," since when it is cut the oyster eventually dies from inablility to close its valves.) The circulatory system of the oyster is of the "open" type; that is, the arteries do not terminate in capillaries which lead to the veins, as in man, but deliver the blood, which is colorless, into large spaces, or lacunæ, between the tissues. The blood, as it spreads through these lacunæ, bathes the various cells of the body and is then gathered up by the veins and collected in the auricle or lower chamber of the heart. It then passes into the ventricle, or upper chamber, which contracts and forces the blood through arteries to the different parts of the body. A hinged valve between the two chambers of the heart prevents the blood being driven back into the auricle.

The nervous system of the oyster (not shown in the figures) is very simple, consisting of two ganglia or knots of nervous matter, lying just over the gullet and two nerves passing back from them, one on each side, to another pair of ganglia beneath the adductor muscle. Smaller nerves extend from these two pairs of ganglia to the various parts of the body.

At the anterior end of the body four thin lips or palps hang free in the mantle cavity and extend backward from beneath the mouth for about one-third the length of the body, the posterior ends lapping under the ends of the gills. The latter, four in number, are somewhat similar to the palps in appearance, and extend backward and upward in crescent fashion, as shown in Plate II. Microscopic examination shows that the gills are covered on both sides with very fine hairs or cilia, arranged in rows. These beat back and forth and, when the oyster is lying with the valves open, cause a current of sea water to pass on to the gills. The water is forced through fine openings on the surfaces of the gills into water tubes inside the gills and thence into the cavity above them. As the water passes through the gills the blood is aerated as in the case of a fish. In Plate II the openings of the tubes can be seen on the inner edge of the gills. The right mantle having been removed, the cavity into which the water passes is exposed. It lies in the space just above the inner edge of the gills.

From this cavity the water passes behind the adductor muscle and out between the edges of the valves of the shell around the rear end of the gills, at a point in the upper left of the figure.

The food of the oyster consists entirely of minute animal and vegetable organisms and small particles of organized matter. Ordinary sea water contains an abundance of this sort of food, which is drawn into the gills with the water, but as the water strains through the pores into the water tu... the food particles are caught on the surface of the gills by a layer of adhesive slime ...ch covers all the soft parts of the body. As soon as they are entangled the cilia strike against them in such a way as to roll or slide them along the gills toward the mouth. When they reach the anterior ends of the gills they are pushed off and fall between the lips, and these again are covered with cilia, which carry the particles forward until they slide into the mouth, which is always wide open and ciliated, so as to draw the food through the œsophagus into the stomach. Whenever the shell is open these cilia are in action, and as long as the oyster is breathing a current of food is sliding into its mouth.[a]

The food then passes to the stomach, is acted on by the fluids from the liver, and moves along the intestine. The nutritive portion is

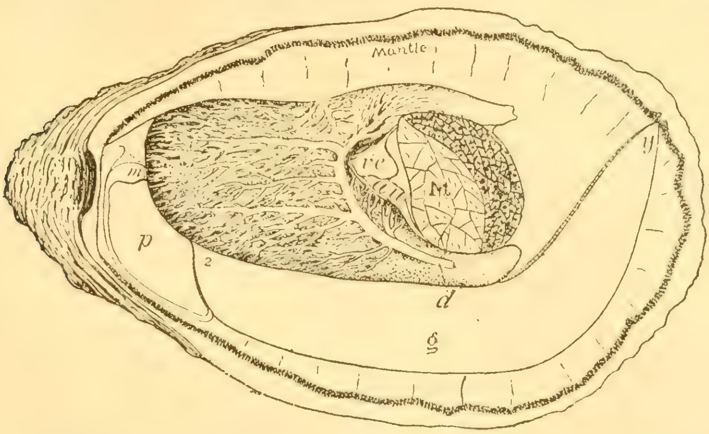

FIG. 1.—Diagram of dissection of oyster to show reproductive organ, consisting of the branching tubules spread over the dotted portion. *au*, auricle of heart; *d*, external opening of reproductive organ; *g*, gills; *M*, adductor muscle; *m*, mouth; *p*, palps; *ve*, ventricle of heart; *y*, posterior end of gills. About natural size. (After Moore.)

absorbed and the feces are thrown out the vent in long, ribbonlike form and carried outside the shell with the stream of water passing out from the chamber over the gills.

The position, form, and general appearance of the reproductive organs of the oyster are the same for both sexes. Really there is but one reproductive organ, which consists of a mass made up of microscopic tubules and connective tissue lying between the folds of the intestine and investing it and the stomach and liver in such a manner as to cover the visceral organs when the opened oyster is viewed from either side. In Plate II most of the reproductive organ has been removed, a small portion being shown about the folds of the intestine. Text figure 1 represents an oyster with the left valve and mantle removed, showing the reproductive organ as it appears from the left side, covering the visceral mass and partially surrounding the heart and adductor muscle. Numerous ducts arise from the organ, unite into one and open at point *d* below the adductor muscle. A view

[a] Brooks, W. K. (1880. p. 9.)

of the right side of the organ would present practically the same appearance, there being a similar system of ducts opening on that side beneath the muscle. Through these two openings the genital products are discharged into the water at spawning time.

LIFE HISTORY.

TIME OF SPAWNING.

The oyster may spawn when the water reaches a temperature of 68° F., but spawning proceeds at normal speed only when the water is 70° or above. For this reason the spawning period varies in different regions, depending on the temperature of the water, which is regulated by the depth of the water and the general meteorological conditions. Shallow bodies of water, even though in more northern latitudes, often become warm as early or earlier than deeper waters farther south. In the north, where the season is shorter, the spawning period is relatively short, often lasting only two or three weeks, while in the south oysters may be found in a spawning condition from early spring until fall.

In Long Island Sound, the bulk of the oysters spawn about the last of July; in Great South Bay, spawning occurs from about June 5 until after the Fourth of July. In New Jersey waters spawning begins about June 1. Spawning extends in Chesapeake Bay from May until September. On the Gulf coast, spawning begins in March and spawning oysters may be found as late as November.

REPRODUCTION.

In spite of the fact that the sex of the oyster can not be distinguished by the external appearance of the shell, of the body, or of the reproductive organs, the sexes are separate. Some oysters are male, the reproductive organs developing spermatozoa or milt; other oysters are female and produce ova or eggs. While it has at times been stated that the sex might change from year to year, an oyster being perhaps male one year and female the next, or the reverse, there is no evidence on which to base this belief, except some inconclusive researches made nearly 50 years ago and not borne out by subsequent investigations. It can be almost conclusively stated that the sex of the eastern oyster is permanent and does not change during the life of the individual.

The sexes can be distinguished only by an examination of the products discharged by the reproductive organs. The spermatozoa and eggs are so extremely small that a lens must be employed to distinguish one from the other. The eggs (Pl. III, fig. 2) vary from roughly pear-shaped to oval or nearly spherical and measure about $\frac{1}{500}$ of an inch in diameter. It is estimated that a female oyster will produce over 16,000,000 eggs. The male genital products, or spermatozoa, are many times smaller than the eggs. Each spermatozoon (Pl. III, fig. 1) is made up of a head about $\frac{1}{10,000}$ of an inch in diameter, pointed at one end and flattened at the other. To this flat base is attached a very slender threadlike tail about 20 times the length of the head. This tail lashes about and moves the spermatozoon around in the water after it has been discharged by the male oyster.

Fertilization of the eggs occurs in the water. The oysters, male and female, lying about over the bottom, at spawning time discharge the reproductive elements into the water where they mingle as chance may bring about. The more numerous the oysters on a particular bed, the greater the chance of the actively moving spermatozoa meeting the eggs. The spermatozoa swarm around the eggs, many about each one, until a spermatozoon penetrates the egg membrane, the head only of the spermatozoon passing on in, the tail dropping off. The material of the head unites with that of the egg, and important changes in the latter are thereby initiated.

The single cell of the egg begins to divide into many cells and to change its form and in the course of from 5 to 10 hours develops into a small oyster larva, which swims by means of fine hairs or cilia on the outside of its body. A shell then begins to develop and soon covers the entire body, so that the larva resembles a tiny hard clam. A definite organ of locomotion also appears, consisting of a disk, known as the velum, borne on the end of a thick stalk which is protruded from between the valves of the shell in front. The disk bears cilia which by their movement enable the larva to swim about rapidly (Pl. III, fig. 4). When the velum is retracted the larva settles to the bottom.

The larva is now about two days old and measures about 0.08 mm. in length. As it increases in size certain elevations, the umbones, can be noted on the upper part of the hinge, one on each side. Shortly one valve becomes much deeper than the other, and the umbo on it much more prominent than that on the right side, and by this characteristic the oyster larva may be readily distinguished under the microscope from the larval form of any other bivalve. The deeper valve is the left one and that by which the oyster later becomes attached. During the advanced stages of the larval form, the left umbo is very conspicuous, jutting back in almost the form of a hook (Pl. III, fig. 3).

The period passed through by the oyster larva from the development of the cilia, a few hours after fertilization, until it "sets" or "strikes" is known as the free-swimming stage. Although the larva swims about freely in the water, being so small, its movements and location at any particular time are largely subject to the tides and currents. The free-swimming period lasts from about 14 to 18 days in the more northern waters and a somewhat shorter time in the southern. The warmer the water the more rapidly development occurs and consequently the shorter the free-swimming period.

At the close of the free-swimming period, when the oyster is about one-third of a millimeter (one seventy-fifth of an inch) long, it "sets" if the proper conditions are present. It attaches itself by the left valve to some surface in the water, a rock, shell, stake, in fact almost any object (Pl. IV).

The first essential is that the surface should be clean and that it should remain so a sufficient length of time to enable the young oyster to firmly establish itself. So long as this condition obtains, the nature of the material seems to matter but little. In most bodies of water the spat fixes itself at all levels from the surface to the bottom but in certain parts of the coast its place of attachment is confined to the zone between high and low water, the midtide mark being the place of maximum fixation.[a]

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[a] Moore, H. F. (1897, p. 274.)

Once secured, the swimming organ disappears and the oyster never wanders again of its own volition.

GROWTH.

The shell is secreted by the mantle, the membrane lining the shell. Horny material is first deposited over the outer surface of the mantle and to this is added lime, forming the familiar hard shell. As the mantle increases in size with the general growth of the rest of the body, and as it can be extended somewhat from between the edges of the valves, new shell material is added to the inner surface of the valve and to the outer edge. This makes each valve thick in the central portion, sloping to a condition of extreme thinness at the edges. The outer edges of the valves of a rapidly growing oyster are so thin and knifelike that care must be exercised in handling them to avoid cutting the fingers.

The rate of growth of oysters varies widely, depending on temperature, density and food content of the water, season of the year, and other factors. Its growth is more rapid in the warmer southern waters than in the colder northern. In Long Island Sound about four years are required for an oyster to reach a length of 4 to 5 inches, or marketable size. In southern waters that size is reached in two years. Oysters if left undisturbed may attain a length of 8 to 10 inches or more. While the exact age which an oyster may reach can not be definitely stated, oysters have been found which appeared from the number of layers in the shell to be at least 15 years of age.

Oysters which have unrestricted space for growth acquire the normal shape shown in Plates I, XX, and XXI. When crowded together, the shape becomes modified, even greatly distorted at times. Often numerous set will fasten upon a relatively small piece of cultch, and as growth proceeds a crowded cluster of oysters will result. If broken apart by pressure of growth or by artificial means, their shape will improve.

The crowding of oysters reaches its climax upon the "raccoon" oyster beds. Raccoon oysters are usually found in localities where the bottom is soft and the only firm place which offers itself for the attachment of the spat is upon the shells of its ancestors. Temperature and other conditions are favorable, growth is rapid, the young oysters are crowded into the most irregular shapes, the shells are long, thin, and sharp-edged, and eventually the mass of young is so dense that it crowds out and smothers the preceding generations which produced it and offered means for its attachment. Oysters crowded in this excessive manner are poor-flavored, as well as ill-shaped, but both defects are corrected if they be broken apart, as may be readily done, and planted elsewhere.[a]

FACTORS OF ENVIRONMENT.[b]

TEMPERATURE OF WATER.

The fact that the oyster is found from Cape Cod to Mexico shows that it can become adapted to living in waters of considerable difference of temperature and in certain regions may withstand wide changes during the course of the seasons. In Long Island Sound

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[a] Moore, H. F. (1897, p. 275.)

[b] The outline of this section, "Factors of Environment," and of the one following, "Natural Beds," and the details of certain topics therein, specifically stated in each such case, are substantially as prepared by Dr. H. F. Moore, Deputy Commissioner of Fisheries, for an uncompleted revision of his "Oysters and Methods of Oyster Culture" (1897).

the temperature over the oyster beds falls in winter nearly to 32° F., the freezing point, and in summer rises to 72° in deep water and 75 to 78° over the inshore beds. In Chesapeake Bay oysters in certain shallow water beds withstand variation from the freezing point, below 32 to 90° F.[a] In the Gulf of Mexico the usual range of temperature over the oyster beds is from 50 to 90° F. The relation between temperature and the spawning of oysters has been discussed on page 12.

DENSITY OF WATER.

The higher the proportion of salt contained in sea water the greater the density. Therefore, it is common practice to estimate the proportion of salt by measuring the density of the water with the salinometer. This consists of a glass bulb with a narrow stem at one end on which are gradings reading from 1.000 to 1.031. The bulb is weighted at the end opposite the stem, so that it will sink somewhat below the surface, leaving the stem projecting from the water. The less salt in the water the less the density and the lower the salinometer will sink. Fresh water is arbitrarily considered as 1.000 and the point on the stem of the salinometer to which the water reaches when the instrument is placed in fresh water is so marked. Grades are marked below that on the stem, the bulb rising higher in the water the greater the density. The highest grade is usually 1.031. For convenience three bulbs are usually used, one reading from 1.000 to 1.011, one from 1.010 to 1.021, and one from 1.020 to 1.031. Common sea water usually reads from 1.025 to 1.026 on the salinometer. Oysters are found in water ranging in density from 1.002 to 1.025, but can not withstand densities lower than 1.007 for indefinite periods. In general they seem to thrive best in densities between 1.011 and 1.022.

Oysters are not usually found out in the main body of the seawater, away from the influence of the fresh water from the streams, where the density is 1.025 or more. It will thus be apparent that oysters have become adapted to a certain range of densities, and natural beds have grown up at points fairly close to shore or in inclosed bays where the salinity of the seawater is modified by the inflowing of fresh water.

MUD, SILT, AND SUSPENDED MATTER.[b]

A bottom composed of slightly shifting sands or of very soft mud into which the adult oysters will sink and on which the minute spat can gain no firm support is alike unfavorable to oyster culture and to the development of natural beds. If, however, hard objects be distributed on or above such bottoms they will become collectors of spat so long as they remain clean and free from slime or sediment, and if it be desired to produce permanent beds or to catch the floating spat for the purpose of seeding other beds it is manifest that, the scouring action of the currents being equal, waters containing a minimum of sedimentary matter are to be preferred to those more or less laden with mud.

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[a] Moore, H. F. (1897, p. 280.)
[b] Moore, H. F. Proposed revision of "Oysters and Methods of Oyster Culture" (1897).

In this connection a distinction must be drawn between beds used for seed production and those employed in growing and fattening stock for the market. Oysters will frequently grow more rapidly in silt-laden waters, on muddy bottoms, or in their vicinity, than they will elsewhere, as such places are usually more productive of food organisms, owing to the larger amount of dissolved material available for the sustenance of the minute plants which constitute a considerable part of the food of the oyster.

Even adult oysters may be destroyed, however, by heavy deposits of silt such as often result from freshets and crevasses. For the purposes of seed culture or the establishment of self-perpetuating beds the most desirable waters are those which contain an abundance of microscopic vegetation with a minimum of suspended inorganic particles, although an organic slime such as rapidly forms on submerged surfaces in some localities is as effective in preventing the fixation of spat as is inorganic sediment. In many places in Chesapeake Bay and in the bays on the New Jersey coast the sediment, as well as the bottom mud, is largely composed of finely comminuted fragments of seaweeds and other vegetable matter the rapid deposit of which soon covers with a flocculent film the surfaces of all objects exposed to it, excepting when the currents are sufficiently strong to exert a scouring influence. During warm weather this organic deposit is likely to undergo rapid decomposition, the toxic products of which sicken and kill the oysters.

The more or less constant dribbling of fine material upon the bottom has comparatively little effect upon adult oysters, operating mainly to cover the shells and prevent the attachment of spat or to stifle the young oysters after attachment. This rain of fine material occurs almost everywhere but especially where the currents are weak, and it is generally in the latter localities that it is of sufficient volume to be obnoxious.

TIDES AND CURRENTS.

The effects of tides and currents upon the development and growth of oysters are quite important. The genital products, cast directly into the water as previously stated, are moved about so that more opportunity is afforded for the contact of the spermatozoa of the male with the eggs of the female.

The free-swimming larvæ are carried to and fro by the tides and currents, and thus when large enough to set are often some distance from where they were spawned. The importance of this fact in the method of oyster culture by planting cultch is very great and the matter is discussed under a separate section on page 31.

Tides and currents tend to prevent the fouling of material upon which the larvæ set by washing away silt and débris. In still water, as in an inclosed bay, the suspended débris has an opportunity to settle upon the cultch and form a slime and film which prevents the attachment of the larvæ. If the larvæ have attached, the deposit is often sufficient to smother them.

Since the food of oysters consists of microscopic materials found in the water (see p. 19), it follows that currents affect the distribution of the food of the oyster. In still water, nearly all the organisms might settle to the bottom or those in the neighborhood of the

oyster might become exhausted. Currents keep the material agitated and cause a fresh supply to sweep across the oyster beds.

Movement of the water also brings a fresh supply of oxygen to the oyster which aerates the blood by oxygen derived from the water passed through its gills.

DEPTH OF WATER.[a]

The known vertical range of oysters under natural conditions is from or near high-water mark to a depth of about 130 feet, the latter extreme occurring over densely stocked and productive beds in Patuxent River, Md. In a large part of the oyster region of South Carolina the natural beds occur almost exclusively between high and low water marks, and some of the beds of Florida are similarly situated, the oysters growing on the aerial roots of mangroves, as they frequently or generally do in Porto Rico and others of the West Indies. In places on the Gulf coast oysters set and grow in limited numbers in the grass on the edges of the marsh prairies above the level reached by many high tides, but in such situations they are frequently killed by freezing.

In the Mississippi delta region a good set is often obtained on cultch planted at or near high-water mark, but the young oysters are removed to deeper water before cold weather arrives.

Elsewhere oysters are rarely planted in this country on bottoms exposed at low water. In most places comparatively shallow depths ranging from 2 to 12 or 15 feet are utilized in oyster culture, but in Long Island Sound the practice has been successfully extended to depths of 60 feet or more.

FRESHETS, STORMS, AND ICE.[a]

Freshets occur with more or less frequency in the rivers discharging near the oyster beds of many of the South Atlantic and Gulf Coast States, and with them are to be classed the crevasses or breaks in the levees which sometimes accompany high water in the coastal streams of Louisiana.

The effects of a freshet are twofold. The most immediate effect is that, owing to the vastly increased volume of fresh water discharged, the salinity of the water over the oyster beds is reduced far below the normal and in many cases becomes fresh or practically so for considerable periods. As already stated in another connection, this is often fatal to the oysters already on the beds, and, even when this is not the case, the production of a set is inhibited during the prevalence of the abnormal conditions.

Freshets also carry large quantities of mud and débris scoured from old channels and washed from the land, and as the currents slacken in the bays and estuaries, where the oyster abounds, their carrying power diminishes, and the materials are dropped on the beds. If the deposits so made be deep, the old oysters may be killed, while even a light deposit is sufficient to prevent the attachment of spat until it be again gradually scoured from the shells and other hard bodies on the bottom.

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[a] Moore, H. F. Proposed revision of "Oysters and Methods of Oyster Culture" (1897).

It sometimes happens that a freshet of unusual severity, while disastrous in its immediate effects, results eventually in an increased productiveness of the beds. If the disaster be due to a prolonged freshening of the water without an undue deposit of silt, the shells are often left in a much-improved condition. This is apparently due in part to the more active scouring action of currents of more than usual velocity, but mainly to the destruction of the organic slime, which often covers the shells in sea water, and the cultch is thereby left in a more favorable condition for the attachment of spat carried from more or less distant beds. The fresh water also exterminates the drills which feed on the little oysters, and, as Dr. Moore's observations of improved sets under the conditions described indicate that sets usually occur in waters of rather high normal salinity, where the drill ordinarily thrives, it is probable that this action of the fresh water is no unimportant beneficial factor. The oysters, from the nature of their reproductive and developmental characteristics, are able to reestablish themselves much more rapidly than their enemies.

Gales, to have an effect on adult oysters in moderately deep water, must be of extraordinary severity, but they frequently do great damage or exterminate beds in shoal water. The waves sometimes pick up the oysters and throw them on the beach, but more frequently they are destroyed by being buried in situ by sand, seaweeds, and débris piled up by the sea. Cases are known of where well-established beds have been overwhelmed by such deposits and others in which thick strata of sand between layers of old shells indicate a succession of such disasters in the more or less remote history of the beds.

Sometimes the eroding effect of currents and waves will uncover the buried oysters and shells, and the beds will again reestablish themselves through the attachment of young; but in other cases the beds are permanently destroyed. The former is the usual result when the reefs rise rather abruptly from the surrounding bottom, and the latter is frequent when they are but little elevated above the general floor of the sea. Planted beds, which usually lie at the general level of the bottom, are usually permanently covered.

Gales are sometimes agents in the establishment of new beds, carrying oysters and shells to surrounding barren bottoms, where they form a nucleus that gradually develops into economic importance. Certain productive beds at the eastern end of Mississippi Sound, by character and by repute, appear to have been so established.

The free-swimming larvæ are more susceptible to the weather conditions than are the adults, and cold rain storms, which would have no effect on the latter, undoubtedly kill large numbers of the swimming young. This was first noticed by Ryder and has been amply corroborated.[a]

Ice is occasionally destructive to oyster beds quite independently of the factor of temperature. When heavy ice grounds at extremely low tides, it sometimes crushes the oysters or presses them into

[a] The author and J. S. Gutsell, during the study of the occurrence of free-swimming oyster larvæ in Great South Bay, 1919, found that the average number in 50 gallons of water was 8,339 on July 8. A violent squall and rain followed, together with a drop in temperature of 5° F. On July 11, as soon as collections could be made, the average number had dropped to 3,558 larvæ per 50 gallons of water.

the bottom, and occasionally they freeze fast to the underside of the ice and are carried away when it floats.

FOOD OF THE OYSTER.

The food of the oyster consists of microscopic plants and animals and organic detritus growing or found in the water on and above the bottoms on which the oysters lie, or carried to such waters by currents.

A large proportion of the oyster's food is made up of the plant forms which are known as diatoms. There are many species of diatoms, typical forms being shown in text figure 2. Diatoms are found in more or less abundance in almost all waters, varying greatly

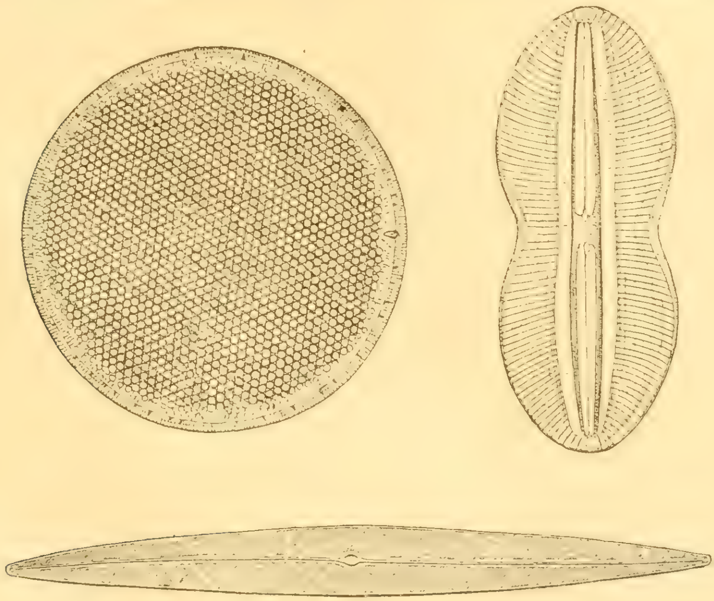

FIG. 2.—Typical diatoms, which make up a large part of the food of the oyster. Magnified about 500 times. (After Moore)

in numbers in different places and at different seasons in the same place or in the same season of different years.

Diatoms derive their sustenance from the various organic materials washed down from the land and held in solution in the water. These organic fertilizers consist of decayed and decaying vegetable and animal matter gathered up from the land by the water resulting from rains and carried down streams and rivers to the sea. The food supply of oysters is thus directly affected by the character of the soil adjoining the tributaries leading to the water over the beds, by the kind and amount of forest or other vegetation and animal life on that soil, by the industries carried on there, and by the amount and seasons of rainfall.

While a large portion of the food of the oyster is made up of diatoms, considerable numbers of microscopic animal forms are

also eaten. The recent work of Dr. T. C. Nelson [a] shows that a larger proportion of the oyster's food is of this nature than was formerly supposed. Copepods, or "water-fleas," the free-swimming larvæ of snails and bivalves (including the oyster), worms, rotifers, and protozoa have been found in the stomach of the oyster. These animals, like the plants, are found in greater or less abundance in all waters. A systematic effort to ascertain the food content available for oysters in any particular water should include the determination of the quantities of the suitable animal as well as plant forms present.

Dr. Nelson kept under observation a number of oysters in water shallow enough for a system of wires and levers to be connected with the shells in such a way that the opening and closing of the valves were recorded on a revolving smoked drum or chimograph in the floating laboratory above. It was found that, during the summer months at least, the oysters remained open, and consequently feeding, for 19 to 20 hours out of 24. Feeding is thus evidently a fairly continuous process during the warmer months.

Organic detritus or débris resulting from the decay and disintegration of plant and animal life undoubtedly contributes to the food of the oyster. As the diatoms and other plant forms become broken up some of their fragments are ingested by the oyster, and a certain amount of nutriment is derived therefrom. After death, animal forms disintegrate and release fats, albumens, etc., into the water. It has been found that the fresh-water mussel may make use of such products, and probably the same is true in the case of the oyster.

NATURAL BEDS. [b]

DEVELOPMENT AND DESCRIPTION.

A natural oyster bed is an area of the bottom on which oysters have become established without the voluntary and intentional agency of man. In law, the term is usually held to include only such bottoms as bear oysters in sufficient quantities to make fishing for them by legitimate methods a means of reasonable livelihood or areas which have formerly been such and whose present character indicates a reasonable likelihood that they may again become productive. The only difference between natural and artificial beds lies in the fact that the latter originate by the intentional act of man, whereas the former arise from natural conditions purely, from accident, or from unintentional human agency incidental to other works and purposes. In most cases the natural beds, and especially the larger ones, have been produced by the operation of factors in which man has no part, and we know nothing of their origin. In a few instances, small beds have been caused by shipwrecks and other accidents; but on the other hand there are many beds, some of them very productive, which have grown on ashes and similar material thrown overboard from vessels and upon shells culled from the live oysters by oystermen and strewn at random over the bottom. Whatever their origins, all oyster beds, if left to

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[a] Nelson, T. C. Forthcoming report, N. J. Agricultural College Experiment Station.
[b] Moore, H. F. Proposed revision of "Oysters and Methods of Oyster Culture" (1897).

themselves will assume the same general physical and biological characters in so far as their environments permit.

The natural beds of the Atlantic and Gulf coast practically all lie like islands in a sea of mud more or less soft. In some places the oysters are in clusters rooted in the mud, in others the substratum is hard to a greater or less depth, but examination will show that this hardness is in most cases superficial, and below it lies mud of a consistency corresponding to that which surrounds the bed. There are a few beds which have grown on rocky bottom, and there is a larger number lying on firm, unshifting sand; but there are few rocky outcrops on the coast south of New England, and most sandy areas tend to shift more or less and engulf such oysters and shells as may be lying on them. The oyster is an inhabitant, par excellence, of the muddy bays, sounds, and lagoons, and in them attains its best development.

In tracing the history of any oyster bed, reference must be made to the nature and characteristics of the young oyster as it develops from the egg. As has been explained on page 13 the embryo oyster is a minute organism endowed with certain feeble powers of locomotion, which are sufficient for awhile to keep it suspended in the water and permit its being carried by the currents. In some cases it may be carried several miles from its parents before the setting stage is attained. The chances are many that when this happens it will lodge on mud and end its story, for so small is the larva at this stage that a mere film of ooze suffices to stifle it. If, however, by rare good fortune it, at this time or just before, comes into contact with a shell, pebble, twig, rocky ridge, or other clean body, whether at the bottom or not, it speedily attaches itself and continues its growth.

So abundant is the supply of larvæ in any prolific oyster region that ordinarily several or many will attach to each square inch of clean surface, and a shell may furnish attachment for a hundred or more. Under such circumstances there soon begins a struggle for existence that is none the less rigorous for being purely passive. As the young oysters grow there is not room for all, and the more vigorous ones, themselves distorted by the crowding, overgrow, stifle, starve, and eventually kill those of slower growth or less advantageously situated. At the end of the first year there has developed a cluster of perhaps from two to a dozen young oysters growing on the original shell, all projecting upward and crowding one another into long, narrow shapes. Upon the projecting mouths of these shells there is another set of spat on the succeeding year, and as this grows some of the survivors of the earlier generation are in their turn crowded and killed. The result of this is that in the course of a few years there is formed a cluster like an inverted pyramid with its apex being gradually driven into the mud by the increasing weight above, while its broad base is made up of several generations of living oysters attached to the dead shells which constitute the middle parts. The oysters around the edge where they have room to grow are often of fair shape and quality, while those more centrally located are irregular, long, narrow, and usually poor, owing to their crowded condition and difficulty in obtaining food.

From the decay of the hinge ligaments of the dead valves, the corroding effect of boring animals, and the solvent action of seawater on the limy shells, these top-heavy clusters tend to break up under their

own weight and under the force of the waves. On hard bottom the disintegrated parts are rolled about and more or less evenly distributed, resulting eventually in the production of other similar clusters scattered at intervals. On soft mud the shells can not roll so readily, and they fall and remain close to the base of the original cluster, where, if not completely engulfed, they form places of attachment for new generations. If the mud be very soft they sink for a short distance and accumulate until they harden the bottom and form a firm support for the shells which fall later, and which in turn are covered with a growth of young.

As these phenomena recur year after year the original single cluster gradually extends around its edges now more or less at the top until it becomes converted into a little bed composed of a dense mass of clusters, with its boundaries sharply defined and limited by the soft mud surrounding it. A number of other clusters have probably been growing simultaneously on the same muddy bottom, and, the areas between becoming narrowed and obliterated, there results a great flat bed made up of a number of smaller patches separated by a muddy network. Where a deep, muddy channel occurs the oyster growth usually stops near the edge of the slope, the shells which would else serve as clutch sinking down into the deep soft ooze. Opposite the mouths of smaller streams, even where there is no such deep channel, the oyster growth is also inhibited, partly by the freshness of the water, but principally and often entirely by the deposit of silt which soon spreads its thin coating over everything lying on the bottom. In some cases the beds may be completely interrupted, but in others they are continuous in their offshore part, passing by and inclosing the unfavorable area as an oval or subtriangular barren, muddy patch surrounded, excepting on its shoreward side, by productive oyster bottom.

It is difficult to say what may have been the condition of the natural beds in Chesapeake Bay before they were disturbed by man, but at the present time they are essentially in the condition so far described, though with their boundaries often ill-defined and the clusters usually smaller and less dense as a result of tonging and dredging. They usually exhibit no great depth of shells, though the bottom is more or less hardened by their accumulation in the underlying mud. They usually extend alongshore, their greatest length in the direction of the currents and their width extending from a couple of feet below low water toward, and often to, the edge of the deep, muddy channels.

In South Carolina and adjacent regions the beds are of essentially the same type, excepting that they are smaller and narrower, and particularly that they are crowded closer to the shores and almost entirely confined to the area between high and low water, a situation impossible in Chesapeake Bay and more northern regions, owing to the killing cold of winter.

Further development in the history of natural oyster beds beyond the stage which has been described results in a gradual thickening of the deposit of shells and the production of a short reef or lump, with a more or less distinct shoaling of water over its top. The living oysters standing vertically in the dense mass, with their growing tips directed upward and kept clean by the currents, present the only available place for spat fixation. Each year the set occurs on preced-

ing generations, raising the living parts of the bed higher above the bottom, while the interstices beneath become filled with old shells, fragments, sand, and mud to form a compact mass. Eventually, in shallow water, the living oysters approach low-water mark or in some parts of the coast rise above it, where their progress is arrested by cold or long periods of exposure to the air.

Each year a set may occur only to be killed in winter, the dead shells, fragments, sand, and mud piling up under wave action, until the crest may become raised to a level several feet above high water, producing a shell island usually surrounded by a more or less dense growth of live oysters. Such islands are not uncommon in the South Atlantic and Gulf States, and they frequently accumulate in time a growth of grass and brush, which more or less obscures their true character. Sometimes the material is thrown up around their edges atoll-like, leaving a depression in the middle in which muddy deposits collect and support a growth of brush. In places where the bottom is composed of very soft mud the sides of these lumps are comparatively steep and soundings will change 1 or 2 feet within a few yards, the difference being due to the depth of shells and oysters.

In open waters, not especially subject to freshets, where the currents are moderate and the silt carried not excessive, such lumps tend to maintain a round or oval outline, with no great difference between the long and short diameters; but where the currents are rapid or the bodies of water constricted, there, as soon as they rear themselves well above the bottom, they show a strong tendency to grow transversely to the tides, especially if the water be silt-laden. Such long, narrow reefs are common in the rivers of North Carolina and in the bays and rivers of Florida, Alabama, Louisiana, and Texas. In James River, Va., and probably in other rivers of the Chesapeake region, the beds, while often showing their greatest extent in the direction of the current, usually have their shoalest parts transversely to it or are made up of a series of transverse shoals and ridges composed of a dense mass of shells and fragments.

The reasons for this transverse development are as follows: The upgrowing reefs form partial dams or obstructions to the flow of the currents, and, in accordance with well-known laws, cause eddies or backwaters on both the side presented to the current and on that sheltered from it, in tidal waters the two being periodically reversed with the reversal of the tide. When the velocity of a silt-laden stream is checked, it deposits part of its load in the slack water, and, under the conditions stated above, mud falls on the upper and lower sides of the reef, while the somewhat accelerated flow around the ends scours the shells and keeps them clean and fit to receive fresh sets of young oysters. These factors operate more energetically the more heavily silt-laden the water, and they would become nonoperative in perfectly clear water. Not only does heavily silt-laden water deposit more mud when its velocity is checked, but it scours more energetically when its velocity is accelerated, the particles of sand and other materials carried in suspension, acting as so many small brushes to rub off such materials as may have previously lodged. The greater volume of water passing the ends of the reef has still two other effects—it brings a large number of swimming larvæ in contact with the shells and it carries more food to the oysters living there. Clean cultch, abundant larvæ, and ample food, three principal factors in

heavy production and rapid growth of oysters, are, therefore, found better fulfilled at the ends of the reef than at the sides lying across the currents. This tendency to transverse growth once established is increased with every increase in the length of the reef, the jetty effect, retarding the flow of water in one place and accelerating it in another, becoming more pronounced.

It frequently happens that reefs similar in general character to those just described begin their development from or close to the shore, usually at projecting points. They grow, of course, principally at their outer ends and extend outward from the shore at right angles to the current, maintaining a nearly uniform width throughout their length.

In the foregoing description of natural beds consideration has been given solely to the oyster itself, but the conditions are always complicated by the presence of other organisms between which and the oyster there are more or less complex biological relations. Some of the minute forms, especially the plants, constitute the oyster food, while many of the larger species either prey actively on the oyster or its young or compete with it in the struggle for food, oxygen, and space in which to grow.

DEPLETION.

Until the last 40 years the majority of the oysters taken from Cape Cod to Mexico came from natural oyster beds which covered an area of such great extent that they were regarded as inexhaustible. That this belief is quite erroneous is shown by the fact that on the northern parts of the coast, where the temperature is about the minimum for the support of oysters, the natural beds have disappeared or have become sadly depleted. Those of Massachusetts are greatly exhausted, and few are found in Narragansett Bay. On the Connecticut coast only two beds of importance remain—one in the mouth of New Haven Harbor and one west of Stratford Lighthouse, near Bridgeport. There are very few in New York waters. Many of the beds of Chesapeake Bay are seriously or quite depleted, although many still remain. From that point southward the depletion has not been nearly so great, as the oyster fishery has not been pursued as vigorously and the environment has been such that the oyster reproduced much more abundantly than in the north, where a failure to obtain set is only too common.

In some cases the depletion or destruction of natural beds is the result of natural causes, such as the cutting off of the inlet to a bay or sound and the reduction of the salinity of the water; the covering of the beds with silt, débris, and fresh water during a freshet; the shifting of sand or mud by storms; or the inroads of living enemies.

The greatest enemy to the oyster, however, is man. Most of the depleted condition of the natural oyster beds is the result of careless overfishing by oystermen. The beds are stripped down so completely that not enough adult oysters are left to furnish sufficient spawn to insure a subsequent crop. Although millions of eggs and spermatozoa are produced, those products are thrown into the water, where many of the eggs fail of fertilization; many eggs and larvæ die or are eaten by enemies; and many fall at setting time on soft bottoms and are smothered. The percentage that finally reaches the adult

stage is relatively small. For that reason too complete removal of the adult oysters from a bed destroys hope for an ensuing generation.

During the past 40 years certain methods of oyster culture have been developed, especially in certain regions, whereby new beds have been built up and a constructive system of increasing the oyster supply has been initiated in addition to the negative one of restrictions on fishing, such as close seasons and the like. Biologists have become concerned in this work, and efforts have been made to promote, by experimentation, methods for the improvement of oyster culture.

CULTIVATION.

From the table on page 5 it will be seen that about half the oysters produced in the United States are taken from private or planted beds, the rest coming from natural or uncultivated areas. It will also be noted that in New England over 90 per cent of the oysters are produced on planted beds, that in the Middle Atlantic States the natural beds are considerably in excess, and that in the South Atlantic and Gulf States the proportion of natural beds is much higher yet. The table shows, however, that the value of the oysters from the planted beds is nearly twice that of those from the natural. This is due largely to the better quality and shape of the oysters produced by cultivation.

It is intended mainly to set forth here the methods of oyster culture which so far have proved to be commercially successful on the Atlantic and Gulf coasts, together with such suggestions concerning their improvement as biological science has to offer. Since there yet occasionally arise false hopes that the so-called artificial propagation, or the hatching and rearing of oysters in tanks or ponds, as is done in the case of fish, is on the verge of practical accomplishment, it may be well to dispose of this matter before proceeding to the treatment of the successful methods mentioned above.

ARTIFICIAL PROPAGATION.

This attempted method of oyster culture can be treated most simply by stating that its perfection and practical application are substantially no nearer solution than when the problem was opened up by Brooks (1880, pp. 10 to 18). He succeeded in artificially fertilizing the oyster eggs with spermatozoa of the male oyster and in rearing some free-swimming larvæ to the age of four or five days. Brooks's methods are in themselves not difficult, and the experiment has been repeated time and again both by biologists and laymen. Owing, however, to the immense practical difficulties of restraining the microscopic larvæ in receptacles or tanks and at the same time providing for a change of water and the introduction of the proper food and removal of waste, no one has succeeded in rearing many of the larvæ until they attach to cultch. It would seem, moreover, impossible to do this on a scale sufficiently large to be of practical application in the oyster industry.

The same statements are true regarding the adaptation of this method, in which attempts were made to substitute for the tanks ponds connected by narrow inlets or ditches with tidewater. While

elaborate designs have been constructed for the manipulation of such ponds and the catching of set on cultch placed in the ponds or the connecting ditches, none has proved to be of any practical value whatever. The principal difficulty seems to have been that, in the effort to confine the set to the pond, too scanty an inlet was provided for the entrance and exit of the tide, and the oysters suffered in consequence. In the cases where efforts were made to catch the set on cultch placed along the connecting canal, if the latter were broad enough to allow sufficient rush of water to keep the cultch clean, most of the set passed out to sea.

Oysters, on the other hand, will reproduce, grow, and fatten in ponds or inlets to which the tide has access in sufficient volume to render the water properly saline, provide the requisite food, and remove the débris. The set from such oysters is at the mercy of the tide; some may be caught in the pond or inlet, and some will be carried outside. In France ponds or "claires" are profitably maintained for the growth and fattening of oysters. The seed oysters placed therein consist of set from outside oyster beds which has been caught on collectors placed in the water along the beach.

While it can not be said that the problem of so-called artificial propagation may not be solved at some future time, for the present it must be emphasized that oyster culturists should base no false hopes on the practical application of this method.

In view of the barren results of 40 years' experiments in this line, it is best to devote attention to the amplification and perfection of methods which have proved to have a certain measure of success and which are applicable to the industry as carried out on such a vast scale in the United States.

LEGAL CONSIDERATIONS.

PROCURING GROUND.

In order to carry on oyster culture either by catching set or planting seed oysters, it must first be ascertained whether ground for that purpose can be leased or otherwise obtained from the State and, if so leased, whether public sentiment is such that the laws will be respected and enforced. In some States ample provision is made for the rental of oyster grounds and the lessee is protected. Oysters are not taken from his beds any more than corn is taken from a man's cornfield. In other States conditions have been in the past such that protection of leased ground, if attempted at all, was an absolute failure. Considerable improvement is noted, however, in this respect within recent years.

In selection of ground for locating oyster beds care must be exercised to avoid waters into which trade wastes are discharged in quantities sufficient to kill either the free-swimming larvæ or the oyster after it has set. It has been found that certain trade wastes from factories are injurious to oysters if present above certain concentrations. Further, the Federal and State health laws must be borne in mind in order to avoid grounds condemned by health authorities because of pollution by sewage. Stringent laws forbid the use of such grounds for raising or fattening oysters.

MARKING BEDS.

Some States employ competent surveyors, and oyster beds are laid out with the aid of ranges, such as important natural objects or special signals set for the purpose. The planters then place stakes or buoys along these lines in such a way that each man knows exactly where his boundary line lies. Such practice is to be highly recommended as tending to avoid disputes and litigation.

METHODS OF OYSTER CULTURE.

Owing to the great size of the oyster beds, to the large number of oysters handled, and to the high price of labor and the relatively low price of the product, it is not practicable in the United States to use the intensive methods of oyster culture employed in European countries, such as France, or in Japan. In those countries, special devices are used for catching the oyster spat and the individual oysters are removed by hand from the collectors and placed on specially prepared bottoms or in ponds for growth and fattening. In the United States, oyster cultivation, in general, is limited to operations which can be carried on by mechanical means on a fairly large scale over areas of considerable size, thousands of bushels of oysters being involved.

Oyster culture in the United States involves two main methods, the catching of spat, or "set," on artificially placed cultch and the planting of "seed" oysters. Where oyster culture is practiced one or the other or both of these processes is carried on, depending on the region and the desires of the planter.

CATCHING OF SPAT, OR "SET."

As stated previously, for some days after hatching the young or larval oyster is free-swimming. At the close of that period, it becomes attached to some fairly smooth, hard surface in the water, usually rocks, shells, etc., on the bottom. Once fixed, it is there for life and never wanders but proceeds to develop and grow. Failing to make such an attachment, it dies. Both while free-swimming and for a time after fixation the oyster larvæ are referred to by oystermen as "set."

Advantage is taken of this habit of the oyster larvæ, and artificial means are employed to increase the area of suitable surface upon which to "catch a set" of young oysters. Various sorts of material are put down to provide a suitable surface upon which the set may become attached. The material used for such a purpose is known as cultch. The most commonly used cultch is oyster shells, although the light thin shells of other bivalves, especially the "jingle" shells, are sometimes employed. Oyster shells, being available in great quantities from the opened oysters, may be returned easily to the bottoms, thus providing the cheapest, most abundant, and most suitable form of cultch for the large beds cultivated by American oyster planters.

After a set is thus obtained on the shells it may be left there to mature into oysters of marketable size, or the shells with the attached set may be taken up and shifted to other beds. This is commonly

done in the fall after setting occurs, but sometimes set is allowed to grow for a year or two and then treated as "seed," which is discussed on page 33.

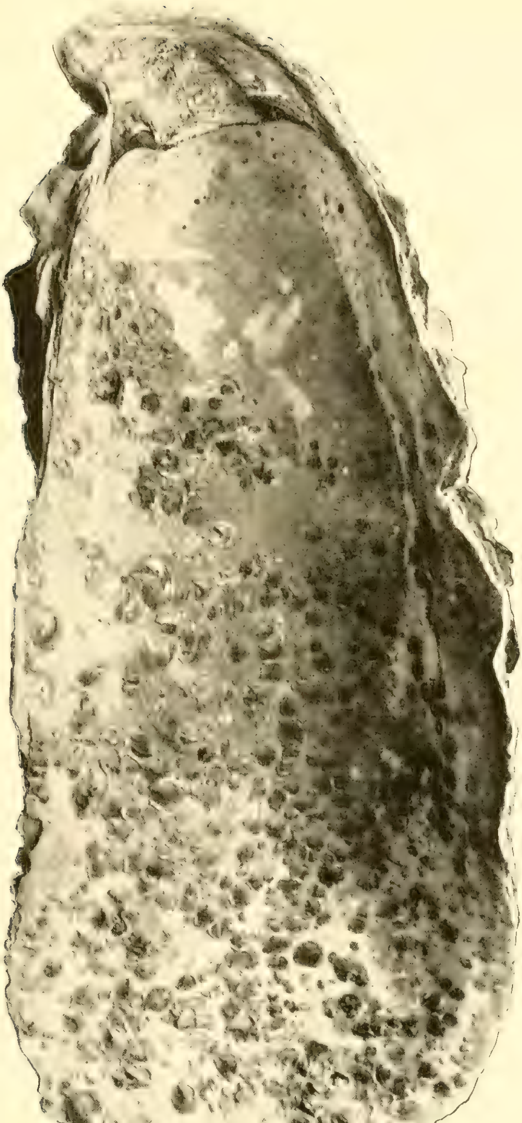
This method of oyster culture is more extensively practiced in Long Island Sound, Narragansett Bay, on the southern side of Long Island, in New Jersey waters, and in Louisiana than elsewhere. The bottoms are cleaned up by dredging from them the old shells, débris, etc. This is done in May, after the close of the season. The shells are put down during the last half of June or the month of July. In Long Island Sound the old rule was to begin "shelling" the day after the Fourth of July. In Louisiana the shells are put down in June, since the oysters spawn earlier there because of the higher temperature of the water.

For shelling purposes in northern waters, the shells are usually loaded upon large scows (Pl. V, fig. 1) and towed out to the grounds by steamers or gasoline boats. Then while the scow is towed slowly back and forth over the beds, the shells are shoveled overboard by men on the scow (Pl. V, fig. 2). If the ground is new and somewhat soft, sufficient shells are put down to form a firm coating such that the upper layers remain clean and exposed above the mud. In any case, enough shells are put down to form a fairly level continuous layer over the bottom.

In northern waters, examination is made about September 1 to 15 to see whether a set has been obtained. Since many factors—such as time of spawning, condition of the cultch, temperature of the water, storms, currents, etc.—enter in to affect the setting, this is the most critical point in the cultivation of oysters by this method and is the one at which the most failures occur. If no set of consequence has fixed on the shells, sometimes they are left until the following season and "harrowed" just before setting time by dragging over them an oyster dredge with the bag removed. This stirs them up and cleans them somewhat, so that often a fairly suitable surface is provided for the attachment of set. Often, however, they are dredged up and heaped upon the ground beside the oyster house. Here they dry, any oyster enemies upon them dying in the meantime, and may be used over again next season. In case a set (by which the oysterman means a sufficient quantity to be of commercial importance) is found upon the shells, they are either left, in order that oysters may develop on that bed, or are shifted to other beds.

The shifting is accomplished by dredging up the shells, set and all, with ordinary oyster dredges or, rarely, by lifting them with tongs. Sometimes the oysters are moved after attaining the age of one or two years, since growth and fattening proceed more rapidly on some beds than on others, due to differences in food content of the water, etc. In certain places oysters become green, and their sale is hindered by the unsightly appearance. When shifted to certain other beds, this color is thrown off in the course of a few months and the oysters are marketed.

The planting of cultch to catch set is mainly performed on "barren" ground, that is, bottoms practically free from oysters. Such ground is leased from the State or purchased outright by the planters. Some States make ample provisions for such procedure, and the lessee or owner has complete protection for his oysters. In other States public sentiment has not supported efforts to provide for leas-



OYSTER SPAT OR SET TWO OR THREE WEEKS OLD ON INSIDE OF OYSTER SHELL.

Natural size. (After Moore.)

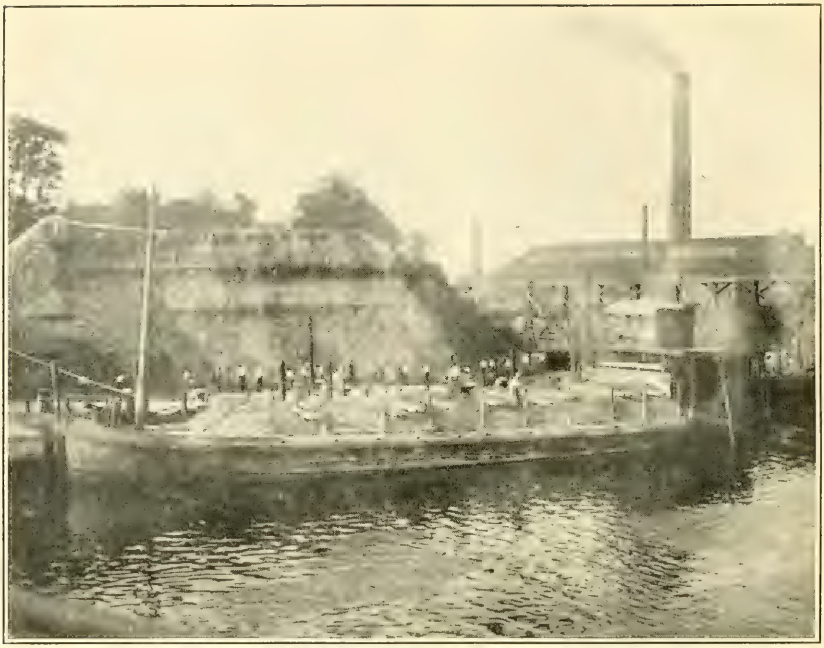


FIG. 1.—LOADING SHELLS ON BOAT FOR PLANTING.

FIG. 2.—PLANTING OYSTER SHELLS IN LONG ISLAND SOUND IN ORDER TO CATCH SET.

The large scow loads of shells are towed by a gasoline boat or steamer.

ing of ground for this purpose and dependence is placed largely on natural beds for the supply of oysters.

In some few cases a State plants a limited amount of cultch upon certain partially depleted natural beds for public benefit. In general, however, the natural beds are staked off and reserved for general public use by the "natural growther" subject to certain restrictions, mentioned elsewhere.

The principal considerations involved in this method of oyster culture are character of the cultch, character and preparation of the bottom, time for planting cultch, the proper location of cultch beds with respect to tides and currents and the spawning oysters, and the location of beds of spawning oysters.

Cultch.—While formerly limited use was made in the United States of various forms of cultch—such as tin cans, bits of pottery, brush, pebbles, "jingle" shells, and oyster shells—only the last three materials have proved to be of practical value, and at the present time the cultch used consists almost entirely of oyster shells. A few "jingle" shells are known to be employed at one point in Long Island Sound. Oyster shells are large and afford surface for the attachment of quantities of spat (Pl. IV). As this grows, overcrowding is apt to result, since the shells are too heavy to be broken apart by the pressure of the developing set. This is overcome by breaking apart and culling the clusters thus formed.

The advantages of oyster shells as cultch consist largely in their general adaptability, presenting a smooth surface for the attachment of the set, and their abundance and convenience, since an oyster-shucking house has only to turn about and convert its shell pile into spat collectors by the use of its own boats. At the same time the gradual disintegration of the shells provides lime for the succeeding generations.

"Jingle" shells, or silver shells, belonging to the species of Anomia, and scallop shells are thinner and more fragile than oyster shells. Consequently, they make a superior form of cultch, since the pressure of the growing young oysters breaks them apart and the formation of clusters is prevented. Unfortunately, the supply of such shells is so limited that very few are now used.

Character and preparation of bottom.—If the bottom at the point where it is desired to plant cultch is sufficiently hard to support it a layer of shells is spread upon it broadcast, as previously described. In case the bottom is soft, it may be prepared by putting down sand or gravel in sufficient quantities to support the shells. Often, however, the bottom is stiffened merely by the use of shells. Sufficient quantities are put down and allowed to sink, until a substratum is formed firm enough to support a layer of cultch several inches or a foot thick above the ground. A bed on which cultch has been placed for several years in succession will gradually be made firmer by the setting of a part of the shells.

Time for planting cultch.—Since sea water always contains more or less suspended débris, which gradually settles upon the bottom or any object thereon it follows that cultch will more or less rapidly become coated with a layer of slime or débris. If this becomes too thick the oyster larvæ are prevented from setting upon it. Movement of the water by tides and currents obviates this difficulty somewhat by washing the débris from the cultch. In bodies of water where there

is little movement, especially in inclosed bays or the like, the deposit accumulates upon the shells rapidly. Such waters, while often very desirable for growing or fattening oysters, are for this reason poorly adapted to catching set.

It early became apparent, then, that it would not suffice merely to spread the cultch at any season of the year most convenient to the planter. Cultch should be put down just as shortly before the bulk of the free-swimming larvæ reaches setting time as it is possible to do it. In general this has been ascertained by experience in the various regions where this method is practiced. For example, in Great South Bay it is planned to complete "shelling" by July 1. In Long Island Sound shelling often begins immediately after the Fourth of July and is completed early in August, individual planters having different ideas as to the best time for planting cultch. In Louisiana cultch is put down in June.

In the case of the large oyster firms, owing to the great quantity of shells handled, it is impossible to concentrate all the shelling into a few days preceding setting time. Such firms often require a month or six weeks in which to complete the process. The best that can be done is to make this period coincide with the weeks immediately preceding setting time.

The proper time of year for planting the cultch has been fixed approximately at certain seasons for each locality, largely by experience derived from the results of some years' practice in this method. The appearance of the adult spawning oysters is noted at intervals each year and the time of planting varied a few days or weeks one way or the other. The aim has mainly been to have the cultch down before any appreciable quantity of spawn has been thrown out by the oysters.

It has been thought until relatively recently that the oyster larvæ set within 3 or 4 days after the spawn was thrown out. It is now known that from 14 to 18 days elapse in New Jersey waters and northward, and a somewhat shorter period in the warmer waters of the Southern States. With this longer period in mind, it will be seen that the time of setting is at least two weeks subsequent to the throwing out of the spawn. In case the spawning period is extended over several weeks, the problem is complicated. In the more northern waters, especially in Long Island Sound, the spawning period has been found to be short, hardly more than two weeks in length, the bulk of the spawn being thrown out in the course of a few days. In such case, keeping in mind the two weeks free-swimming period of the larvæ, it is possible to judge the time of putting down cultch quite accurately.

Since seasonal variations affect the time of spawning, it follows that no exact date which will hold good for each year can be set for planting cultch. As a result of a survey of the free-swimming larvæ made by the Bureau of Fisheries, it was found that the setting time of the bulk of the larvæ in Long Island Sound in 1918 occurred during the week of August 10 to 17. In 1919 there was no setting time in Long Island Sound, since no larvæ developed to setting size, owing, doubtless, to the abnormally low temperature of the water. In 1919, in Great South Bay, setting began about July 1, but the bulk occurred July 15 to 17. These data were secured by following the development and movements of the free-swimming larvæ by

means of examinations of samples of water of definite volume taken in various places from day to day.[a]

This method consisted essentially in noting the number and size of free-swimming larvæ found in samples of water taken daily over the oyster beds by pumping 50 gallons through a net or bag of No. 20 bolting silk. By the study of a considerable number of samples taken each day the general abundance and size of the larvæ could be ascertained and the setting time predicted several days ahead.[b] As the larvæ approach setting time, with the accompanying increase in size, the left valve of the shell becomes very prominent, as stated on page 13. This renders them readily distinguishable from other bivalve larvæ, and it is easy, after a little practice, to recognize them under the microscope.

It would seem that the advent and development of the larvæ could be noted by this means each season. The State commissions could hire a biologist for a month to make the examinations or train one of their own members to do the work. The development and movement of the larvæ could be followed in a few representative places in the waters of the State and exact information relative to setting time ascertained and imparted to the oyster planters. After a few years it would be found that the time varied within certain fixed limits, and examinations would need to be made only to learn the variation within that period for the particular year.

Location of cultch beds.—The different oyster planters have determined by experience the locations at which beds of cultch are placed. After a term of years each man has found the portion of his ground on which cultch may be placed with what seems the most likelihood of getting a set. Individual planters have their own views as to the proper position of the cultch in relation to the beds of spawning oysters. Sometimes beds of cultch and of oysters are placed side by side; sometimes several are located alternately. Some planters place a certain number of spawning or "mother oysters" about in groups on the cultch bed.

Since the free-swimming larvæ are carried about by the tides and currents, it becomes of importance to follow in each locality the movements of the larvæ in order to ascertain as nearly as possible the place in which they will set. This involves a study of the tides and currents and the directions in which and the distance to which they carry the larvæ in any particular bay, cove, or river mouth. Accurate knowledge of these facts would enable one to state where the cultch should be placed in relation to the spawning oysters. Since the tides and currents depend on the contour of the bottoms and coasts, they are the same from year to year, unless disturbed by storm. The data, once accumulated by perhaps two or three years' study, would have permanent value.

Investigations calculated to ascertain the advantages of such knowledge of the movements and points of aggregation of the free-swimming larvæ were carried on in 1919 by the United States Bureau of Fisheries, using Great South Bay, Long Island, as a testing

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[a] Churchill, E. P. Jr., and Gutsell, J. S. Reports on Investigation of Oyster Larvæ in Long Island Sound, 1918 and 1919, *and* Investigation of Oyster Larvæ of Great South Bay. (Contains methods.) Forthcoming reports, U. S. Bureau of Fisheries.

[b] Dr. T. C. Nelson (1916), in his study of the occurrence of free-swimming oyster larvæ in Little Egg Harbor, N. J., was able to ascertain the relative abundance of the larvæ in different areas and to predict the setting date about 10 days in advance.

ground.[a] The method of examining samples of water for numbers of larvæ described on page 31 was employed. It was found to be possible to ascertain from day to day during the spawning season, lasting, roughly, from June 5 to July 17, the number of larvæ per gallon of water at various representative stations in the bay. In this way the points of aggregation of the greatest numbers of larvæ were determined and charted on the map. Beds of shells had been placed at various points in the bay. The quantity of set caught on the different beds substantiated predictions based on the data derived from the study. The heaviest set was obtained from the beds located at the points in the bay where there had been the greatest accumulation of larvæ. To be specific, it was found that the tide caused the larvæ to accumulate along the channel from about Ocean Beach on Fire Island Beach to the inner United States channel buoy, in the direction of Sayville, Long Island. Cultch beds should be placed along this channel where the bottom is or may be made suitable.

By the use of methods such as just described the distribution of oyster larvæ could be worked out for any particular region. The possibilities of this procedure have been discussed above in connection with the recommendation that such lines of investigation be undertaken for the various oyster waters, perhaps by State authorities.

Location of spawning beds.—Oftentimes the catching of set depends as much on the location of the spawning oysters as on the position of the cultch. Both are important, and sometimes the best results can be accomplished only by the providing of the proper relationship between the two. Spawning beds should be placed where conditions are most favorable for spawning, at the same time putting the cultch at a point where the larvæ from the bed will be carried back and forth across it by the tides or be accumulated over it by eddies or cross currents.

For example, in Great South Bay, Long Island, which is large and shallow, the oysters are placed about over the bay at various points where they grow and fatten best, the catching of set from them being a matter of rather secondary importance in this locality. As a matter of fact one place is as favorable as another for the spawning of the oysters, the bay being of fairly uniform depth and salinity. As stated above, the larvæ accumulate in the channel, and cultch should be placed there.

In Long Island Sound a different condition prevails. The catching of set has been a large feature of the oyster industry there. Cultch beds were planted at greater or lesser distances offshore or in the lower part of the mouths of rivers. Owing to a recent failure of the set there, investigations have been made by the United States Bureau of Fisheries during 1917, 1918, and 1919. It has been found that in the past the bulk of the set consisted of larvæ from natural oyster beds in the shallow waters of bays, coves, and river mouths, where the water became warm relatively early in the season and the spawning occurred early enough for the larvæ, carried out by the currents to shell beds in deeper waters, to develop, set, and acquire a fair size before the close of the short summer season

[a] Churchill, E. P. Jr., and Gutsell, J. S. Investigation of Oyster Larvæ in Great South Bay. Forthcoming report, U. S. Bureau of Fisheries.

of that locality. These inshore beds are practically exhausted now, and dependence is being placed for set upon the oysters planted in deeper water offshore. The deeper water warms up slowly, and the oysters spawn so late that the crest of the warm season is over before setting occurs and very little set is obtained from them. In Long Island Sound spawning beds should be placed in the shallow inshore waters to take the place of the original natural beds. Cultch beds should be placed where they have been heretofore, outside or in the lower part of the mouths of rivers outside or alongside the oyster beds.

In this connection, as stated earlier, the fact that certain waters are contaminated with factory trade wastes must be borne in mind. It has been found that the upper waters of certain harbors in Long Island Sound contain such a concentration of trade wastes that oyster larvæ are at once killed by it. No adult oysters are now found in such waters. As these wastes are carried out nearer to the mouths of the harbors they are diluted and are at least not so immediately fatal to the oysters, but ultimately the effect is certainly harmful. Some of the wastes also probably contribute to the green discoloration of the meats of oysters found in certain beds. Vigorous efforts should be made to require the reclamation of trade wastes by the factories and to prevent their discharge into waters otherwise fitted for the maintenance of sea-foods.

General desirability of planting cultch.—The method of oyster culture by means of catching set on planted cultch is the most promising one at present. Small seed oysters may be placed on bottoms where, due to improved conditions, they will grow faster, acquire a more desirable shape, and thus bring a better price. But by putting down cultch in places where there was none before set may be caught which otherwise would have perished. By this method the actual number of oysters in increased. This method should be developed further in some such manner as suggested above and brought into more general use.

At several points on the Atlantic and Gulf coasts no cultch is planted, the shells being burned for lime or used in building roads. In some of these places the oyster beds are becoming seriously depleted. This is especially true of Chesapeake Bay. Investigations carried on there by the United States Bureau of Fisheries during 1919 showed that, while there were abundant free-swimming larvæ during the spawning season, the vast majority of these perished from lack of cultch upon which to attach themselves. It would seem highly desirable to cease disposing of the shells for lime or road building and to clean up the oyster bottoms and plant the shells on them to catch set. The general improvement of the oyster beds and the consequent increase in revenue from them would far outweigh the relatively small amount now received for the shells as at present handled.

PLANTING SEED OYSTERS.

In the method of oyster culture by planting seed the start is made with small or "seed" oysters instead of shells. Such seed oysters may vary in size from set of a few months' growth, about the size of one's finger nail, to oysters of nearly marketable size in some cases.

They are usually, however, small oysters attached to old shells or other material upon which they originally caught. Sometimes, if fairly large, the individual oysters are removed from the old shells or the clusters broken up before planting. Seed may be bought or taken by the planter from his own or natural beds.

Very little seed is now taken from Chesapeake Bay and planted in Long Island Sound, although the importation of "southern" oysters and seed was formerly an extensive practice. The oyster beds of Maurice Cove in Delaware Bay are kept up by the planting of seed taken from the natural beds in the bay. Seed oysters are planted in Chesapeake Bay to some extent and in York River, Va. To a lesser extent the planting of seed oysters is carried on in other States. In many of the Southern States the clusters of small "coon" oysters are broken apart and used for seed. Such coon oysters grow in abundance along the shores and naturally are so thickly crowded together that they acquire a long, narrow shape and are quite indifferent oysters. If the clusters are broken apart and the oysters put down on suitable beds when an inch or two long, they grow into fair-shaped, marketable oysters in about a year in southern waters. Seed oysters are planted at various times of the year, depending on the local conditions, in some places in the fall, in others in the spring.

A number of oystermen make a business of taking shells bearing set from natural beds and selling it to the large planters to be placed on their leased beds as seed. No shells are planted upon natural beds, except by the State in certain cases, the set attaching to shells left by the death of adult oysters, or to rocks, débris, etc. The material bearing the set is taken from such natural beds by the use of tongs (Pl. XI) or by light dredges lifted by hand or hand windlasses on a sailboat (Pl. XV, fig. 1).

In nearly all States it is illegal to use other than a sailing vessel on natural beds and in most instances the dredge must be lifted by hand or by a hand windlass, although sometimes it is lawful to lift the dredge with a donkey engine on deck of a sailing boat. The purpose of restrictions on the use of steam and power in dredging is to limit dredging on natural beds to the use of the less efficient apparatus in order to conserve the supply of oysters. In most States such "natural growth" may not be taken from the beds during certain of the summer months, the purpose being not to disturb the beds during spawning and setting time.

In northern waters it requires from four to five years for an oyster to reach marketable size (a length of from 4 to 5 inches, measured in the shell). In Chesapeake Bay three years is sufficient, while in the South marketable size may be attained in two years. Oysters grow more rapidly in the warmer waters.

In oyster culture by the method of planting seed the main considerations are the kind of seed, character of the water, food supply, bottom, sowing the seed, and caring for the beds.

Seed.—Seed oysters vary in size from the set just caught that season and taken up in the fall, when it is about the size of a finger nail, to oysters which will attain marketable size within a few months after planting. The majority of the seed, however, is not more than $1\frac{1}{2}$ inches long. It is obtained from "natural growthers" who make a business, as stated above, of taking seed oysters from natural beds and selling them to planters, or by the planter himself gather-

ing them directly from the beds. In many places the larger planters buy of the "natural growthers", since steam vessels and heavy dredges, such as are owned by the large oyster companies, are not allowed to work on the natural beds. The "natural growther," with less capital, can afford to maintain a vessel and some hand dredges and profitably sell to the large oyster company, which in turn obtains seed more cheaply than it could by supporting its own sailing vessels and crews. In States where such a system is practiced, the natural beds are set aside by the State for the "natural growther" with limited capital.

The material dredged from the natural beds usually contains old shells, rocks, and débris, in addition to the oysters. Sometimes the whole is bought at a reduced price, but usually the desirable material is culled out and the clustered oysters broken apart as far as possible.

Water.—As a general rule seed oysters should not be obtained from warm waters and put down in those excessively colder. If this be done, it will usually be found that their growth is checked for some time and that a certain percentage die. After a time, however, they become accustomed to the reduced temperature and renew their growth.

In general, the warmer the water the more rapid the growth of the oysters. This is due both to the greater abundance of food material and to the fact that the bodily activities of the oyster proceed more rapidly when the organism is warmed to a relatively high temperature.

The density of the water should be between 1.007 and 1.023. Although oysters are found both in water of lesser and of greater densities, they do best within the limits stated.

Food.—The character of the food of the oyster is discussed on page 19. In order to profit by planting oysters, a sufficient quantity of food for them must be assured. Often certain waters and bottoms are suitable for catching set on cultch, but do not possess a sufficient food supply to enable the oysters to grow and fatten rapidly. Other grounds furnish an abundant food supply, but the water is so loaded with débris that cultch and set are soon covered. Hence in many cases cultch beds are placed in waters of the former character, and the set is caught and later transferred to waters containing more food.

Care must be exercised not to place more oysters on the ground than can be supported by the supply of food present. On the average about 500 bushels of seed are sowed per acre. The food content of the water varies greatly from place to place and from time to time in the same place. It is affected to some extent by the amount of material brought from the land by the streams and rivers. This again is dependent on the rainfall. As previously stated, diatoms make up a considerable part of the oyster's food and diatom growth is affected by materials washed down from the land. A period of excessive drought causes a falling off in the diatom content of the water.

It would be well if a systematic biological study could be made of the food content of the water over prospective oyster grounds. In order to do this samples of water of definite amounts should be strained through No. 20 silk bolting cloth and the number and

amount of food organisms and material ascertained microscopically.[a] Estimate is usually made per liter, which is about equal to a quart. If it were found from a series of examinations that the food content of the water were conspicuously low, it is obvious that the grounds in question would not be desirable for the planting of oysters.

Bottom.—The bottom is cleaned of débris by dredging. If firm enough to support the oysters, no further preparation is needed. If soft, the surface is hardened by putting down shells, sand, or gravel, deposited uniformly so that there are no holes in the surface as finally prepared.

Sowing the seed.—The seed oysters are removed from the original bed by the use of tongs or dredges and are planted in much the same manner as shells by being shoveled from boats or scows (Pl. V, fig. 2) towed back and forth over the grounds. About 500 bushels per acre are usually planted, though the amounts vary widely with local conditions. The oysters are spread uniformly, so that they may not lie in heaps and cause some to fail to receive the proper amount of food or to be crowded and thus grow irregularly.

Care of beds.—The beds are generally left untouched after planting, except for combating enemies in some cases (see below) and shifting certain of the oysters, if desired, to other grounds for final preparation for market. The oysters to be shifted or sold directly are taken up by the use of tongs and dredges. After the oysters have been removed from the beds the grounds are cleaned up by dredging, when they may be used again for planting cultch or seed.

PROTECTION AGAINST ENEMIES.

The more important enemies of the oyster will be described briefly and the methods, if any, of combating each set forth.

STARFISH.

There are two species of starfish which may be classed as oyster enemies. These are the common star, *Asterias forbesi*, and the purple star, *Asterias vulgaris*. The starfish opens an oyster by inclosing it with the arms or rays (Pl. VI, fig. 1), which are provided with rows of suckerlike feet on the lower side, and exerting a constant outward pull on the valves of the shell, until the oyster is exhausted and the valves are allowed to gape at the ends. The starfish then protrudes its stomach from the mouth, which is on the lower side of the central disk, inserts it between the valves of the oyster shell, and sucks in and digests the meat. The set and 1 and 2 year old oysters are more subject to the inroads of the starfish, because of their smaller size and weaker adductor muscle; but the larger starfish prey on oysters as much as 3 years old.

In certain waters the starfish are very destructive to oysters, often invading and cleaning out a whole bed before the planter is aware of their presence. This is true of New England waters and those immediately to the southward. They are unknown in Chesapeake Bay and constitute a menace to oysters only in the regions mentioned in the preceding sentence. In Narragansett Bay and Long Island Sound it has been necessary to fight them very vigorously.

[a] This method will suffice to determine the great bulk of the food available in the water and is usually sufficient for practical purposes. The material in actual solution in the water, which probably contributes only a small percentage of the food of the oyster, can be determined only by chemical analysis.

FIG. 1.—STARFISH ATTACKING AN OYSTER.

(Photo from Dr. H. M. Smith.)

FIG. 2.—PHOTOGRAPH OF OYSTER SHOWING THE TURBELLARIAN WORM KNOWN AS THE WAFER OR "LEECH."

The worm has fastened itself upon the oyster and appears as a dark wrinkled body in about the center of the oyster meat. Natural size. (After Danglade.)

FIG. 1.—USUAL STYLE OF "STAR MOP" USED FOR EXTERMINATING STARFISH IN LONG ISLAND SOUND.

The stars become entangled in the brushes as they are dragged over the bottom. The mops are then raised and plunged into vats of hot water on deck to kill the starfish.

FIG. 2.—"DISH-PAN" FORM OF STAR MOP, USED IN LONG ISLAND SOUND.

The only practical method of destroying the starfish so far devised is by the use of the "star mop" (Pl. VII, fig. 1). This usually consists of an iron bar about 10 feet long, to which are attached 8 or 10 large mops or brushes of heavy rope-yarn about 4 feet long. The bar moves on small wooden iron-tired wheels as it is dragged over the bottom by a chain attached by three drag bars arranged as shown in the figure. The chain passes through a pulley attached to a stout post amidships, and the mop is raised and lowered in the same way as a dredge. The starfish cling to or become entangled in the mops and are brought to the surface when the apparatus is lifted. Two mops are usually used, one on each side of the boat. A long narrow vat is generally placed inside the gunwale on each side of the boat. These vats are kept filled with water which is heated by steam from the boiler circulated through pipes in the vats. Each mop with its burden of "stars" is dropped into the hot water. This is the most rapid and efficient method of killing the starfish and removing them from the mops. Sometimes only one vat is used, placed across the deck before the cabin, and each mop is swung around and lowered into it by means of a small crane.

Fig. 3.—*Urosalpinx cinereus*, the oyster drill of the Atlantic coast. Natural size. (After Moore.)

In Plate VII, figure 2, is shown a special form of star mop, the "dishpan," devised for use on a rocky bottom. The toboggan-shaped body consists of two pieces of boiler iron, the larger one $4\frac{1}{2}$ by 2 feet and attached to the triangular smaller one by four rings bolted on as seen in the figure. This allows some independence of movement of the two parts. The mops are the same as used with the other form of apparatus. This mop slides over the rocks more readily than the wheeled bar, the brushes falling down between the rocks and catching the stars. This style of mop, however, is heavy and awkward to handle and is not extensively used.

"Starring" must be kept up whenever any considerable number of the enemy appears and should be of a cooperative nature. It is of little avail for a planter to attempt to keep his beds free from starfish, unless his neighbor does likewise.

DRILL.

There are at least four species of snail-like molluscs known to oystermen as drills or screw borers. One of these, *Urosalpinx cinereus* (text fig. 3), attaining a length of about an inch, is found abundantly from Massachusetts to the east coast of Florida. The eggs are laid in small, yellowish, vase-shaped, leathery capsules,[a] deposited in clusters on objects in the water. Another species is *Thais lapillus*, about the size of the preceding. It is found from the east end of Long Island northward. Other species of drills (often called borers, snails, whelks, or conchs) are *Thais hæmastoma* (Pl. VIII, top) and *Thais hæmastoma floridana*. These sometimes reach a length of 3 inches. They are found on the Gulf coast, where they are often very destructive to oyster beds. The eggs are laid in tubular capsules about a half inch long, attached by the ends to

[a] Moore, H. F. Proposed revision of "Oysters and Methods of Oyster Culture" (1897).

shells and other objects in the water (Pl. VIII, center). Masses of these capsules are often found covering oyster shells so thickly that there is danger of smothering the oysters. From their reddish-purple color these masses are often referred to as "red grass."

The various species of drill possess a rasplike apparatus which can be protruded from the mouth. With this they bore a hole through the shell of the oyster (Pl. VIII, bottom) and suck out the contents. Drills destroy many young oysters, their thin shells being relatively easily penetrated. After the oyster becomes older its shell is heavy enough to resist the effort of the drill.

In Long Island Sound it has been found that about the most practical method of lessening the numbers of this enemy is the following: The teeth are removed from an ordinary oyster dredge, and a bag with meshes of an inch or less is put on in place of the usual coarser one. After the oysters have been taken off the bed for market or shifting, the specially equipped dredge is used and everything left—shells, drills, débris, etc.—is dredged up

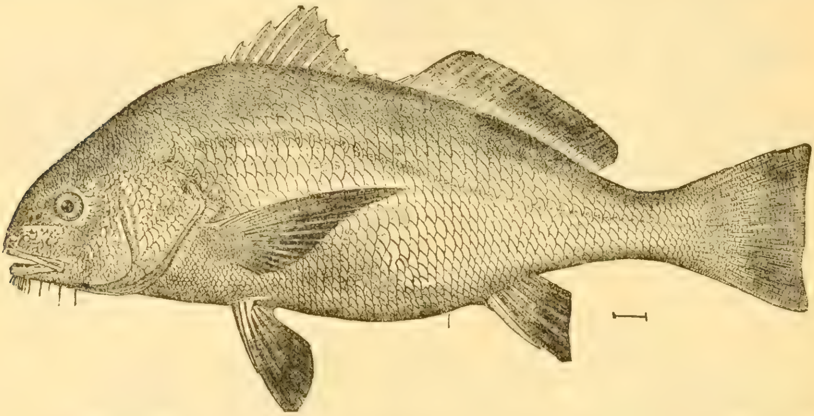


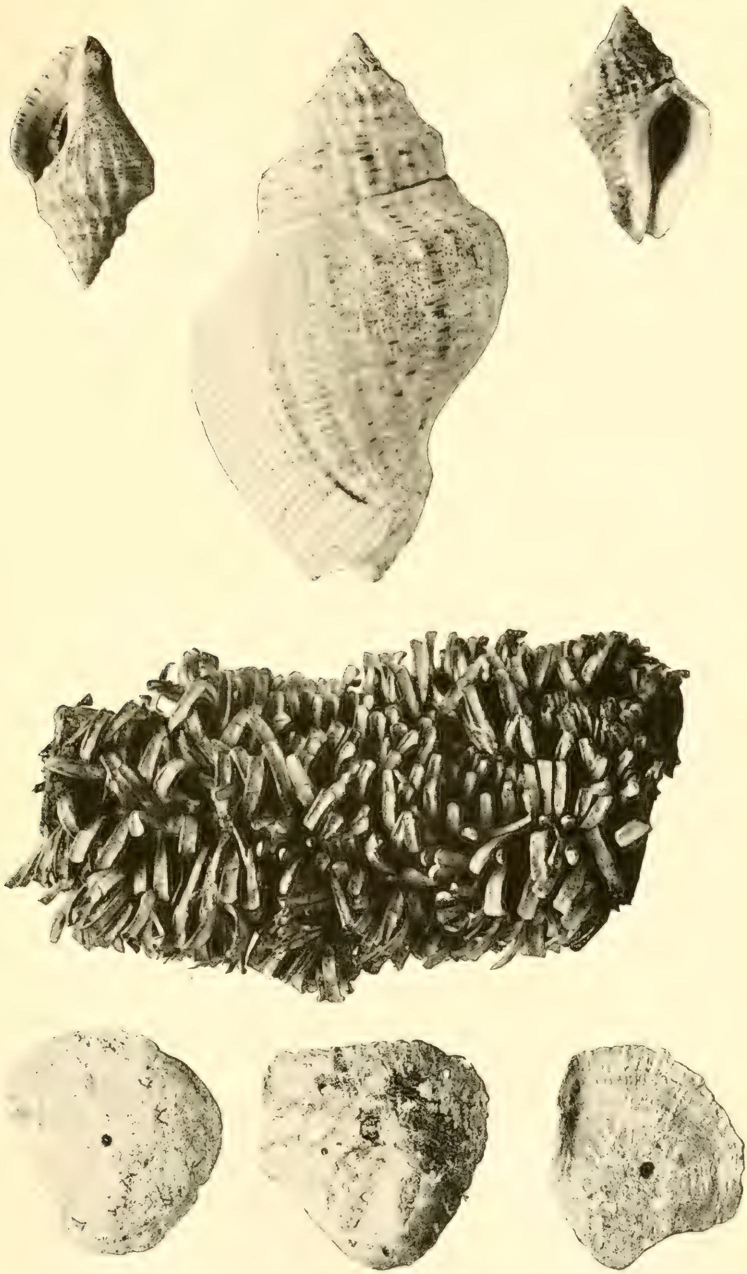
FIG. 4.—*Pogonias cromis*, or drum fish. At times this fish destroys large numbers of oysters. (After Jordan and Evermann.)

and dumped ashore to dry. The drills die, and a good deal of the material may then be used as cultch.

DRUMFISH.

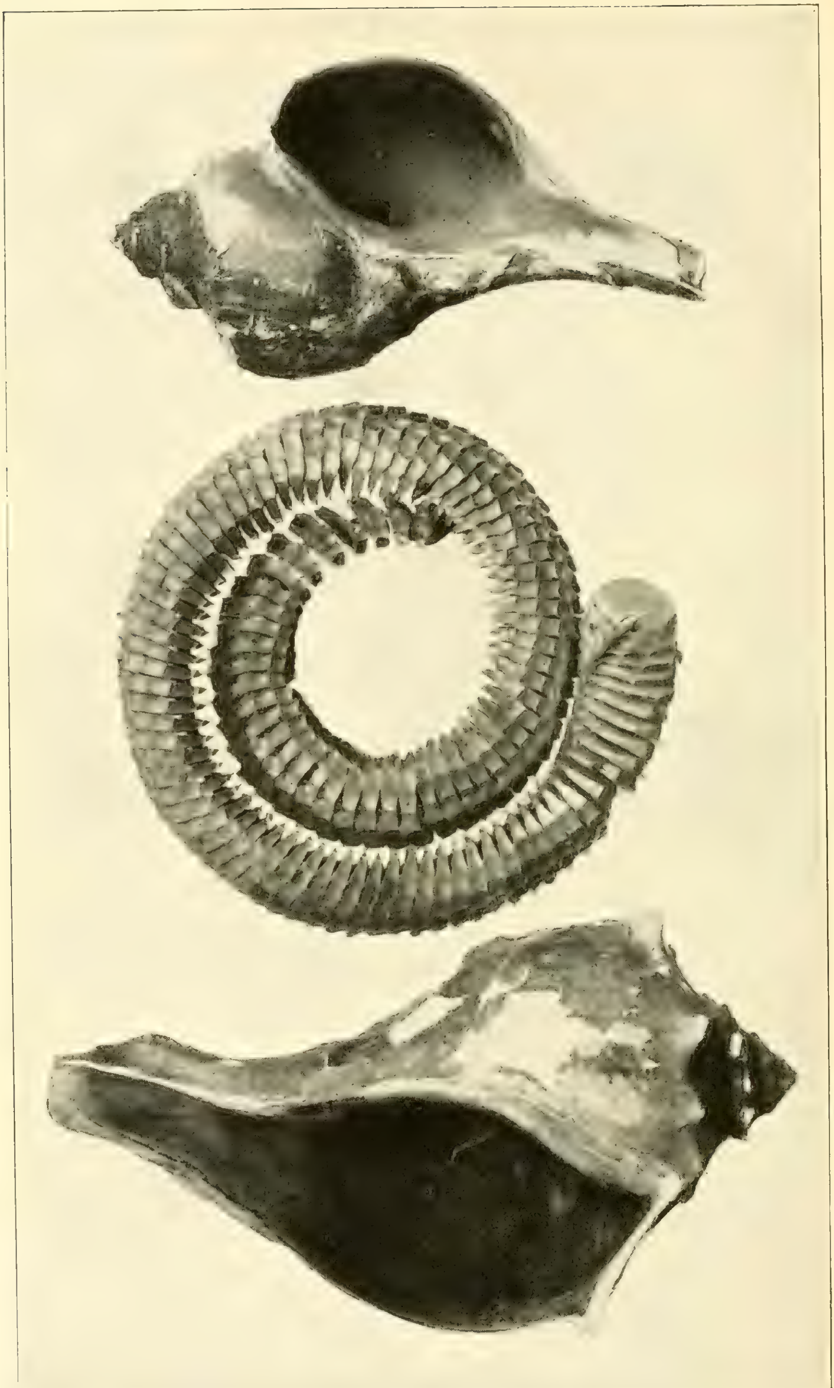
The fish known as the "black drum," *Pogonias cromis* (text fig. 4), is found at intervals of time and place from New Jersey to Texas and is often very destructive to oyster beds. It attains a length of several feet and has a heavy body with large stout teeth. The oysters are crushed, shell and all, by these strong teeth, the younger thin-shelled ones being, of course, especially subject to the depredations of the drumfish. These fish go in schools and their attacks are spasmodic, often whole oyster beds being cleaned out in a short time and then, again, no drumfish being seen for several months or years.

Efforts have been made to kill or frighten away such fish by the explosion of dynamite, but no particular success has been achieved. In southern waters, especially in Louisiana, where oyster beds lie in shallow water and there is not much tide, it has been found practi-



TOP, BORERS OR "DRILLS" (THAIS HAEMASTOMA) OF THE GULF COAST; CENTER, SO-CALLED "RED GRASS," THE EGG CASES OF THE BORERS; BOTTOM, OYSTER SPAT DRILLED BY BORERS.

Natural size. (After Moore and Pope.)



CONCHS. TOP, CHANNELLED CONCH OR WHELK, BUSYCON CANALICULATUM; CENTER, STRING OF CAPSULES CONTAINING EGGS OF KNOBBED CONCH; BOTTOM, KNOBBED CONCH OR WHELK, BUSYCON CARICA.

cable to fence the beds with chicken wire strung on posts set in the bottom.

CONCH.

This is also a snail-like mollusc, comprising several species, some of which attain a length of from 5 to 6 inches. *Busycon carica* and *Busycon canaliculatum* (Pl. IX) are the most common. The eggs are deposited in flat parchmentlike capsules about an inch in diameter and strung together by a cord along the side to form a loosely spiral chain a foot to a foot and a half in length. This is cast free from the animal and left to the mercy of the waves. It has been found[a] that the conch opens an oyster by inserting the edges of its own shell between the valves of the oyster when it gapes (text fig. 5) and then introducing its proboscis and eating the meat. Conchs do not occur, however, in sufficient quantities to destroy many oysters. No definite means of combating them are employed, although those taken when dredging are usually killed.

FIG. 5.—Conch opening an oyster. About one-half natural size. (After Colton.)

MUSSEL.

Mussels, the common edible species, *Mytilus edulis*, and other species, of the Atlantic waters, and *Mytilus hamatus* (Pl. X, fig. 1), of the Gulf coast, are bivalves which, shortly after hatching from the egg, attach themselves to material on the bottom by a slender thread or hair called the byssus. As development goes on the number of hairs is multiplied and they become shorter and stouter until the adult mussel, at a length of 2 to 4 inches, is very firmly attached by these threads. The mussels multiply rapidly, and dense beds are sometimes formed over the oysters, tending to smother the latter. Since the mussels feed upon essentially the same materials as do the oysters, there is always danger of a greater or less exhaustion of the food supply.

In Long Island Sound the mussel is attacked in the following manner: The mussel spawns and "sets"—that is, attaches by the byssus—perhaps a month or more before the oyster. Advantage is taken of this fact, and when evidences are found of an alarming number of young mussels on the oyster beds, they are "harrowed" by dragging over them an ordinary dredge with the bag removed or open at the back. This process crushes and destroys the majority of the tiny mussels without injury to the adult oysters. If this process is carried out on a bed planted with shells to catch a set, no harm is done, as the oysters have not yet spawned, and there is consequently no oyster set on the shells.

[a] Colton, H. S. How Fulgur and Sycotypus eat Oysters, Mussels, and Clams. Proceedings, Academy of Natural Sciences, Philadelphia, Vol. LX, 1908, pp. 3–10, 5 pls. Philadelphia.

BORING SPONGE.

Boring sponge (*Cliona celata*) is the term applied to a yellow sponge which begins its existence by boring (Pl. XXI, lower left figure) in the shell of the oyster, where it forms small tunnels, in which it lives. The shell is gradually honeycombed, and the oyster becomes weak and thin from the effort to seal up the openings where the tunnels penetrate the shell completely. The sponge also spreads over the outside of the shell and often smothers the oyster by its very size. No means of protection against the sponge can be suggested, but fortunately it does not occur in sufficient numbers in most regions to prove a serious menace.

BORING CLAM.

The boring clam (*Martesia cuneiformis*, *M. smithii*, and *M. corticaria*) is a species of clam which enters the shell of the oyster by boring a small round hole and excavating in the substance of the shell, at the inner end of the hole, a hemispherical cavity (Pl. X, fig. 2) in which it then spends its life, often attaining a length of three-eighths of an inch. The clam usually does not penetrate the shell entirely and does not feed upon the oyster. It attains its food through the external opening. It does comparatively little damage to the oyster.

WAFER OR "LEECH."

This is a turbellarian worm (Pl. VI, fig. 2) of undetermined species which on several occasions has destroyed large numbers of oysters in the vicinity of Cedar Keys, Port Inglis, and Tampa, Fla. This worm is nearly flat, more or less circular in outline, and is about three-fourths of an inch long. It finds its way between the valves of the oyster and feeds upon the meat, eventually killing the oyster. It flourishes in water of fairly high salinity, and its ravages are checked by lowered temperatures. No method of combating it can be suggested other than a careful working of the beds and the use of new air-dried cultch and fresh seed stock.

TAKING OYSTERS FROM THE BEDS.

Oysters are commonly taken by the use of hand tongs, patent tongs, dredges lifted by hand or hand windlasses, or dredges raised by engines or hoisters turned by the engine of the boat. These forms of apparatus and the boats on which they are used are described below.

TONGS.

Ordinary hand oyster tongs are shown in Plate XI, figures 1 and 2. There are two long, flat, smooth, wooden handles about 3 inches wide and nearly 1 inch thick, bolted, riveted, or pinned together with a wooden pin, scissors fashion, about 4½ feet from one end (see figures), leaving the long ends for handles. To the short end of each shaft is secured at right angles a light iron bar, about 3½ feet long, bearing teeth, while above this bar are five or six still lighter bars or heavy wires parallel to the bar and attached to the shaft. The ends of the bars or wires are fastened together by short wires. The arrange-

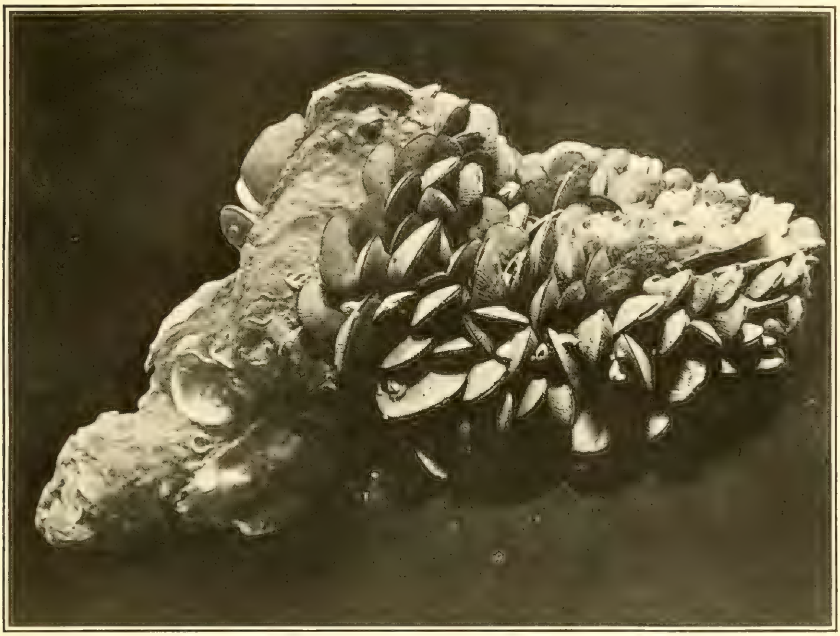


FIG. 1.—MASS OF MUSSELS ATTACHED TO OYSTERS.
(After Moore.)

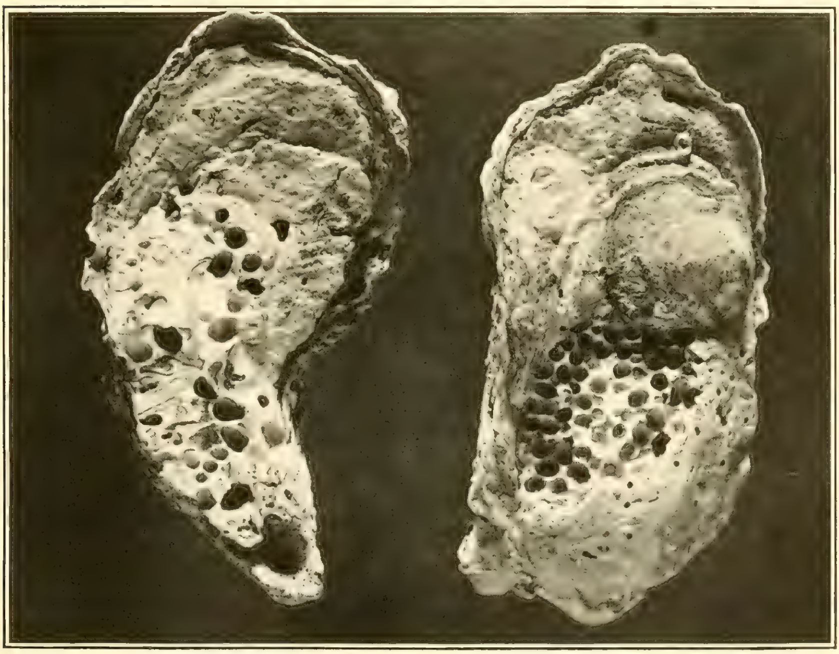


FIG. 2.—OYSTER SHELLS SHOWING PITS AND CHAMBERS MADE BY BORING CLAM.
(After Moore.)

FIG. 1.—TONGING OYSTERS, WORKING THE TONGS ON THE BOTTOM.

(Photo from Prof. E. N. Cory, Maryland State University.)

FIG. 2.—TONGING OYSTERS, LIFTING AND EMPTYING THE TONGS.

(Photo from Prof. E. N. Cory, Maryland State University.)

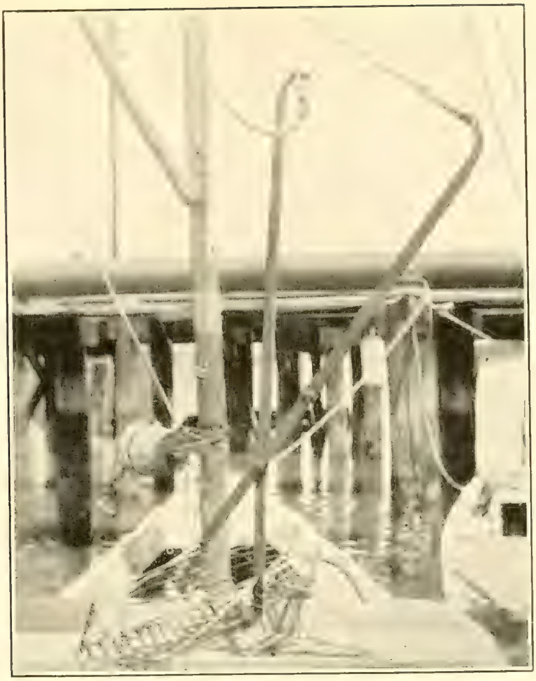


FIG. 1.—PATENT TONGS, USED TO SOME EXTENT IN TAKING OYSTERS IN THE LOWER PART OF CHESAPEAKE BAY.

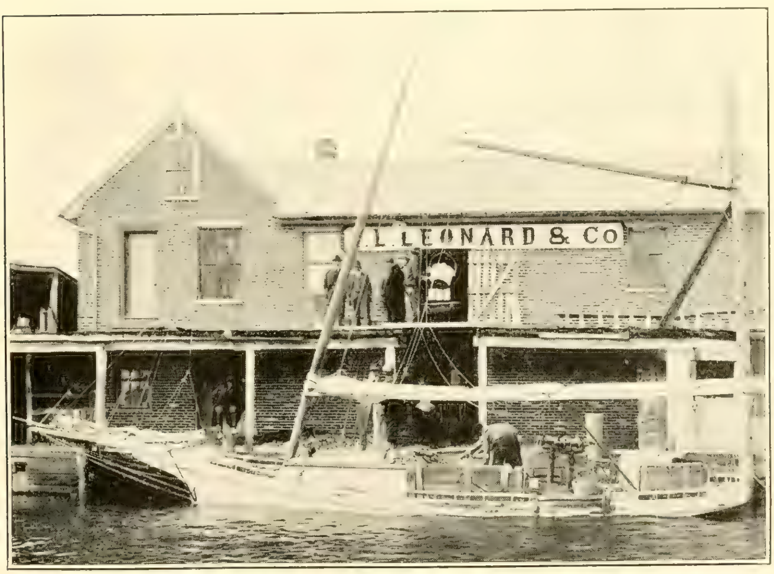


FIG. 2.—UNLOADING OYSTERS BY MEANS OF A CRANE OPERATED BY A DONKEY ENGINE IN THE SMALL BUILDING AT THE RIGHT.

(Photo from Prof. E. N. Cory, Maryland State University.)

FIG. 1.—SMALL SAILING BOAT USED IN TONGING OYSTERS IN QUINNIPIAC RIVER, CONN.

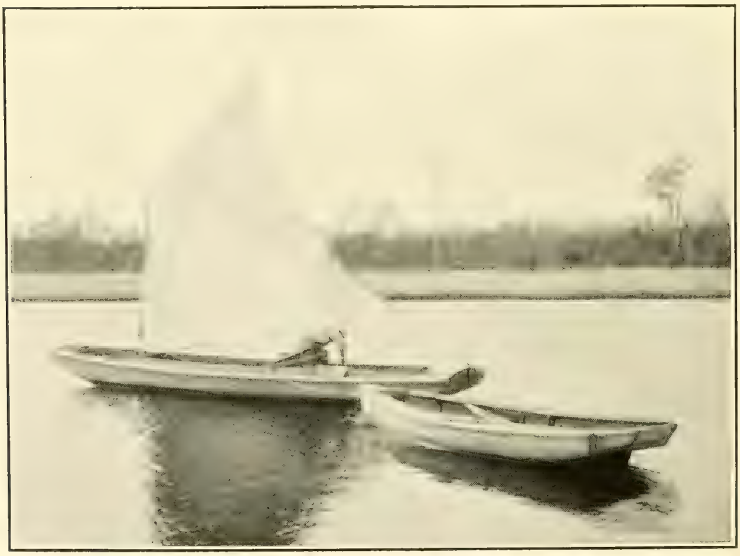


FIG. 2.—SMALL SAILING BOAT USED IN TONGING OYSTERS IN RIVERS ON THE COAST OF ALABAMA.

ment on each shaft is made with the teeth sloping inward, and when the handles are closed the two are brought together, the whole forming a basketlike affair, $3\frac{1}{2}$ feet long by about 8 or 10 inches deep. In operation (Pl. XI, fig. 1), the handles are worked scissors fashion, and the teeth forced under the oysters retained in the basket, which is then lifted (Pl. XI, fig. 2). Oyster tongs vary in length with the depth of water in different localities. In some places, as in the Rappahannock River, oysters are tonged with such apparatus from a depth of at least 20 feet.

PATENT TONGS.

Patent tongs are used quite extensively in Virginia and but very little elsewhere. From Plate XII, figure 1, it will be seen that their general construction is similar to that of hand tongs, except that the handles are of iron, about 6 feet long and provided with an eye at the end for the attachment of ropes for lowering and raising the tongs. The basket of the tongs is of considerably heavier material than in case of the hand tongs. Patent tongs are employed in water too deep to admit of the use of ordinary tongs and are raised and lowered by a spool or windlass, as in Plate XII, figure 1. While being lowered the tongs are locked open by the short hook seen on one of the handles just above the center pin. When they strike bottom, the consequent release of the weight of the baskets on the handles allows the hook to become disengaged. The tongs are then "jigged" by jerking upon the rope several times, causing the teeth to sink more deeply, and then lifted by the windlass.

SMALL TONGS AND NIPPERS.

In very shallow water of perhaps 2 to 4 feet in depth small tongs are often used. These consist of two wooden handles about 7 feet long, arranged as in the case of the ordinary tongs, but with only a single bar on each about 10 inches long, each bar being provided with teeth. This instrument is much lighter and more convenient to use in shallow water than ordinary tongs, especially where only a few barrels of oysters are desired. Such tongs are sometimes called "nippers." In other regions the term "nipper" is applied to a device of a similar nature, except that, instead of ending in a toothed bar, each handle terminates in a narrow blunt blade, thus forming true pincers or nippers, with which single oysters can be taken or dislodged from rocks or pilings.

TONGING BOATS.

In Plate XIII, figures 1 and 2, and Plate XIV, figure 1, are shown various styles of tonging boats. Plate XIII, figure 1, shows a small boat used on Long Island Sound; and Plate XIII, figure 2, a small tonging boat at Bayou Labatre, Ala. Plate XIV, figure 1, shows the type of tonging boat used at Apalachicola, Fla. These boats often carry an auxilary gasoline engine besides the sails. Such a boat with engine is seen in the figure, returning with a load of oysters which have been obtained by tonging. Boats of this sort often have a shallow hold into which oysters are piled until full, after which they are heaped on deck. Plate XII, figure 1, shows a boat equipped with patent tongs.

On the small boats, in compliance with State law, the oysters are culled on a board placed across the boat, as in Plate XI.

DREDGES AND DREDGING BOATS.

The hand dredge is shown in Plate XV, figure 1. It consists essentially of two triangles made of three-fourths inch iron bar, joined at the apices, and the bases separated about 18 inches by curved bars, as seen in the figure at left. It usually measures 4 or 5 feet in width. The base of the lower triangle consists of a bar about 1½ inches thick, to which are welded teeth about 3 inches long, set about 3 inches apart. To a ring at the apex of the dredge a rope or wire cable is attached, by which the dredge is lowered and raised, either by hand or by the hand windlass. Plate XVI, figure 1, shows a small dredging sloop or "skipjack" under sail on Chesapeake Bay, the dredge on the port side being lifted and the hand windlass visible beyond it. In some States, as Maryland, somewhat heavier dredges than this are operated by the use of a donkey engine placed on the deck of a sailing vessel (Pl. XVII, fig. 2). Plate XVI, figure 2, shows such a dredging schooner at work. These vessels are propelled entirely by sails, it being illegal to dredge with other than sails as motive power; the engine merely operates the dredge.

From one to three dredges are usually operated from each side of the boat, each dredge being raised and emptied in turn. Plate XVII, figure 1, shows the dredge being thrown overboard and the roller over which the chain moves in lowering and raising it. After the full dredge is lifted it is allowed to rest on the roller and is emptied by pulling the bag forward (Pl. XVII, fig. 2), thus turning it wrong side out and dumping the oysters on deck. The dredge is then dropped overboard again. The oysters are culled on deck and then shoveled into the hold or onto the pile on deck.

A yet heavier and stouter form of dredge (Pl. XV, fig. 2) is used where dredging with power boats is allowed. It will be seen to resemble the other patterns, except that it is largely made of heavy, flat, iron bars, about 2 inches wide and nearly 1 inch thick and firmly braced. The lower part of the bag is of iron mesh instead of cotton. Dredges of this sort measure from 5 to 7 feet in width and hold 12 to 15 bushels of oysters (one oyster company uses larger ones holding nearly 30 bushels; these are emptied by mechanical means). These dredges are raised and lowered by a heavy chain which passes through a pulley on a stout post in the midline forward and then down to the hoister in the hold. The hoister is turned by the engine of the boat. Plate XIV, figure 2, shows the arrangement of rollers, pulleys, post, and dredges on a gasoline power dredging boat. In Long Island Sound large steamers are often used for dredging on leased beds. One company has two steamers each carrying three dredges on a side, six in all, each with a capacity of nearly 30 bushels. These two steamers are each about twice as large as any other oyster steamer in the world, having a capacity of 8,000 bushels (Pl. XVIII, fig. 2).

FIG. 1.—SMALL SLOOP USED IN TONGING OYSTERS NEAR APALACHICOLA, FLA., RETURNING WITH LOAD OF OYSTERS. SHOWING OYSTER CANNERIES IN BACKGROUND.

FIG. 2.—GASOLINE BOAT USED IN DREDGING OYSTERS IN LONG ISLAND SOUND.

In the center is the post to which are attached the pulleys through which pass the chains leading to the dredges on each side. When the dredges are being raised and lowered, the chains move over the rollers on the gunwale.

FIG. 1.—HAND DREDGES AND WINCHES FOR HOISTING THEM.

(Photo from Prof. E. N. Cory, Maryland State University.)

FIG. 2.—MACHINE-HOISTED DREDGE USED IN TAKING OYSTERS.

FIG. 1.—SMALL SLOOP OR "SKIP-JACK" USED IN DREDGING OYSTERS IN CHESAPEAKE BAY.

The dredge shown lying on the roller is raised and lowered by the hand windlass over which the man is stooping. (Photo from Prof. E. N. Cory, Maryland State University.)

FIG. 2.—OYSTER-DREDGING SCHOONER IN CHESAPEAKE BAY.

(Photo from Prof. E. N. Cory, Maryland State University.)

FIG. 1.—LOWERING THE DREDGE.

(Photo from Prof. E. N. Cory, Maryland State University.)

FIG. 2.—EMPTYING THE DREDGE.

In this case the dredge has been lifted by a donkey engine, part of which may be seen at the right. (Photo from Prof. E. N. Cory, Maryland State University.)

FIG. 1.—OYSTER FLEET OPERATING FROM CAMBRIDGE, MD., LYING IN HARBOR.

Cambridge is only one of the several important oyster centers on Chesapeake Bay. (Photo from Prof. E. N. Cory, Maryland State University.)

FIG. 2.—ONE OF THE TWO LARGEST OYSTER STEAMERS IN THE WORLD, BOTH OWNED BY A NEW ENGLAND COMPANY.

Three dredges lifting 30 bushels each are operated on each side. The capacity of the steamer is 8,000 bushels per day. (Photo from H. C. Rowe Co.)

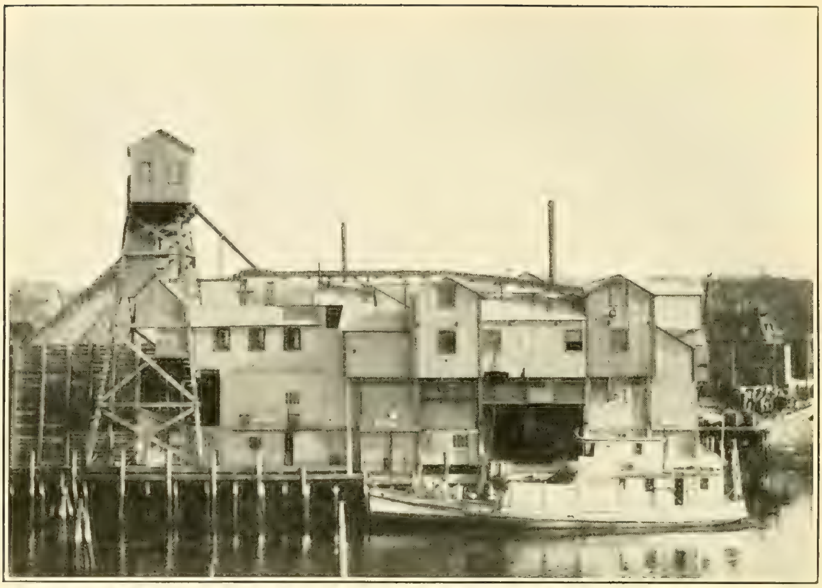


FIG. 1.—LARGE OYSTER HOUSE AT PROVIDENCE, R. I., SHOWING DREDGE BOAT UNLOADING OYSTERS AT RIGHT AND ELEVATOR TO SHELL PILE AT LEFT.

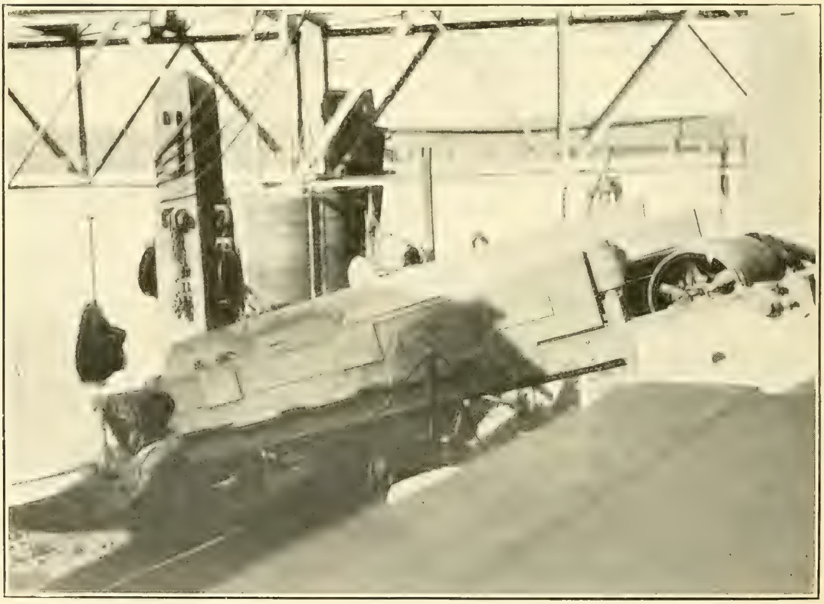


FIG. 2.—UNLOADING OYSTERS FROM THE BOAT AT ONE OF THE LARGE OYSTER HOUSES BY MEANS OF A BELT CONVEYER.

UNLOADING AT WHARF.

In most cases the oysters are shoveled from the hold or deck into large measures or buckets and hoisted to the wharf by a rope passing over a pulley and operated by hand or by a crane with a donkey engine as motive power, as in Plate XII, figure 2. The buckets are emptied onto the wharf and the oysters removed later in wheelbarrows; or into wheelbarrows and the oysters rolled into the shucking room on a level with the wharf, or sometimes to a storage room on an upper floor (Pl. XII, fig. 2). Some large oyster companies have arrangements whereby the buckets are lifted directly into the storage room, and some have an elevator, the end of which may be lowered into the boat and the oysters shoveled onto an endless belt or other carrying device (Pl. XIX, fig. 2).

This carrier transports the oysters directly to the storage room or drops them into another endless bucket-chain carrier which does so. In case the oysters are to be canned they are dumped from the buckets, which have lifted them from the boat, directly into cars, which are then pushed into the steamers inside the cannery.

FLOATING.

Brief mention may be made of the practice whereby, in some localities, oysters, after being taken from the beds, are "floated" for a time before being used. This process is accomplished by spreading the oysters out in a large shallow barge or float so constructed that, while resting at the surface, water may freely circulate through it, the oysters thereby being covered at all times. Such floats vary considerably in structure, often consisting of a rectangular framework some 12 or 15 feet wide by 20 to 30 feet long, made of four large timbers 15 or 18 inches in diameter, with a bottom of boards laid so that cracks are left between them. The float may be towed to the desired point and anchored either before or after the oysters are placed in it.

The floating is usually undertaken for one of two purposes—purification and cleaning of the oysters or temporary storage. In certain regions oysters from beds which are exposed to sewage are floated in waters of a certain degree of saltness designated by the health authorities until any possible impurities contained are thrown off. In such salt water the oysters do not become bloated, as they would if floated in fresh. Oysters are also sometimes floated in order that they may free themselves from sand or dirt contained in the intestinal tract.

Some companies maintain floats such as described in which a temporary stock of oysters may be kept a day or two in order to have a supply on hand to fill extra orders or to tide over a shortage caused by failure to obtain sufficient stock directly from the beds, for any cause, such as the breakdown of a boat or formation of heavy ice over the beds. In this case the floats are placed by the oyster house in water of about the saltness of that over the beds.

The practice of floating oysters in fresh water of creeks and rivers for the purpose of "fattening" has largely died out or been suppressed by health authorities. The oyster did not fatten in such circumstances, but merely enlarged itself by absorbing creek water which the consumer paid for at oyster prices.

PREPARATION FOR MARKET OR SHIPMENT.

Oysters are usually shipped in three general conditions—in the shell; shucked, on ice; and canned.[a] The building where oysters are handled in either or both of the first two conditions is referred to as an oyster house or, in some sections, especially to distinguish it from a cannery, as a "raw house" or "raw-oyster house." If oysters are canned, the plant is known as a cannery. Plate XIX, figure 1, shows the front view of a large oyster house. Oyster houses are provided with a wharf of some sort, so that the boats may be unloaded directly, as described above.

IN THE SHELL.

Oysters are shipped in the shell usually in barrels, sometimes in sacks, without ice, although for long distances a refrigerator car is often used. In many cases, especially for shorter hauls or transportation by river boats, the barrels are not headed, a piece of heavy gunny-sack being fastened over the top of the barrel. A considerable export trade in oysters to England is carried on from the waters of New York and New England. These oysters go in barrels holding 3 bushels and one-half peck, headed up. Only the best-shaped, selected oysters are used for the export trade.

A large number of oysters are thus handled in the shell, since oysters on the half shell have found a place on the menu of the leading hotels and restaurants. For this purpose oysters from certain beds have come to be esteemed as most desirable. These have acquired trade names by which they are universally known and which are derived from the locality from which the oysters are taken. The best-known examples are the Blue Points from beds near Blue Point, a cape on the south side of Long Island; Cotuits, from Cotuit Harbor, Mass., and Lynnhavens, from Lynnhaven Bay, Va. There is a growing tendency to look upon these terms merely as trade names and to employ them to designate any oyster answering the requirements of size and shape of these oysters, regardless of the waters from which they were taken.

Blue Points (Pl. I) are small oysters, about 3 to 4 inches long by 2 to 2½ inches in width. They are rather rounded in form and the shells are fairly smooth. The meats are small and of very delicate flavor, making these oysters very acceptable when served raw on the half shell. For this reason Blue Points have acquired a wide reputation. Lynnhavens (Pl. XX) and Cotuits (Pl. XXI) are larger oysters than Blue Points and of more angular shape. Because of their fatness and flavor they have become highly esteemed.

Oysters are shipped in the shell to points on the Pacific coast both for the market and for planting as seed or for fattening. In 1915, over two-thirds of the 156,104 bushels of oysters produced on the Pacific coast were raised from transplanted eastern oysters.[b]

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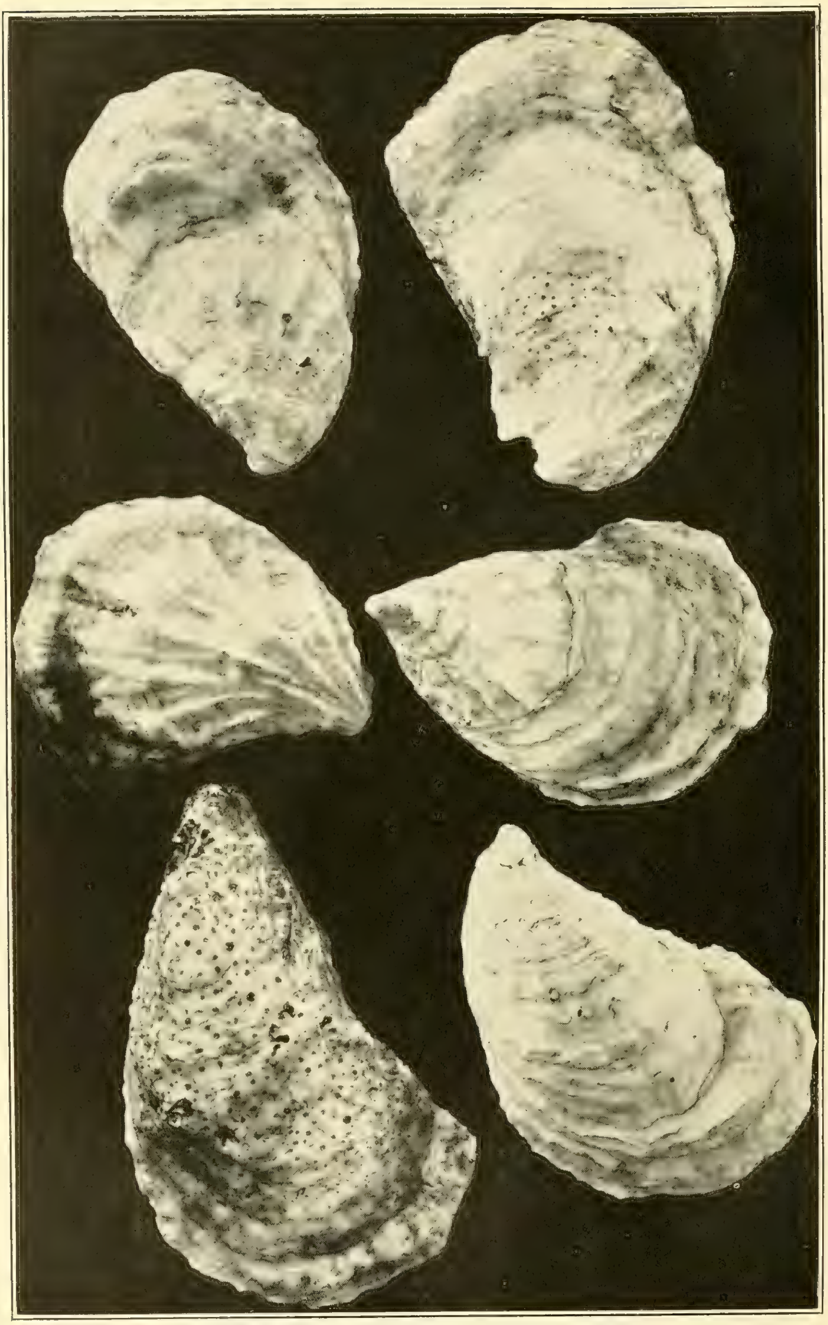
[a] One firm puts out an oyster powder made by extracting in a vacuum the moisture from oyster meats. This powder is sold in small vials packed in pasteboard cartons and is used in making broths and soups. So far as the writer is aware, only one firm puts such a product on the market.

[b] Radcliffe, L. Fishery Industries of the United States. Report of the Division of Statistics and Methods of the Fisheries for 1918. Appendix X, Report, U. S. Commissioner of Fisheries, 1918, 167 pp. Washington, 1919.

"LYNNHAVENS," FROM LYNNHAVEN BAY, VA.

About one-half natural size.



"COTUITS," FROM COTUIT HARBOR, MASS.

About one-half natural size.

FIG. 1.—SHUCKING TABLE IN LARGE OYSTER HOUSE.

The oysters come down from the storage room above and out the bottom of the V-shaped chute. The worker stands on the bench and places the oyster to be opened on the small block on the edge of the table.

FIG. 2.—WASHING FRESH OYSTER MEATS ON "SKIMMING BOARD."

(Photo from Prof. E. N. Cory, Maryland State University.)

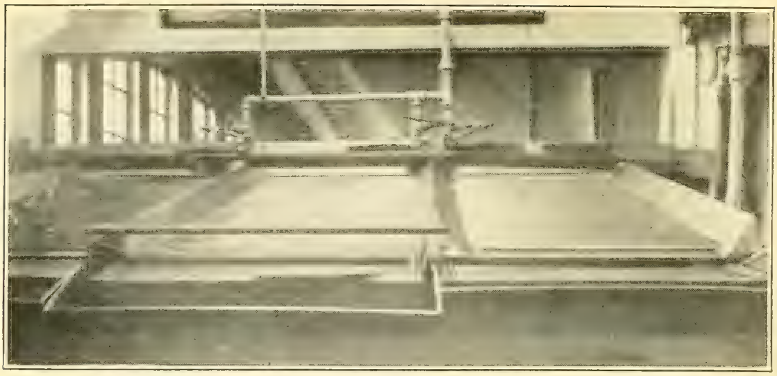


FIG. 1.—"RIFFLE" OYSTER WASHER, ON WHICH FRESH OYSTER MEATS ARE WASHED PREPARATORY TO BEING PACKED ON ICE.

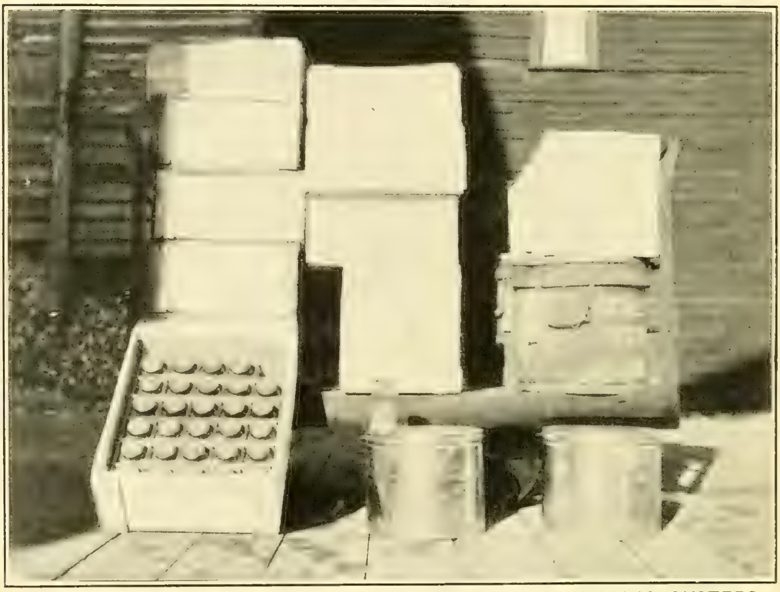


FIG. 2.—SEVERAL STYLES OF CONTAINERS USED IN SHIPPING OYSTERS.

Shucked oysters are placed in metal or glass containers, which are packed in the boxes or tubs with cracked ice about them.

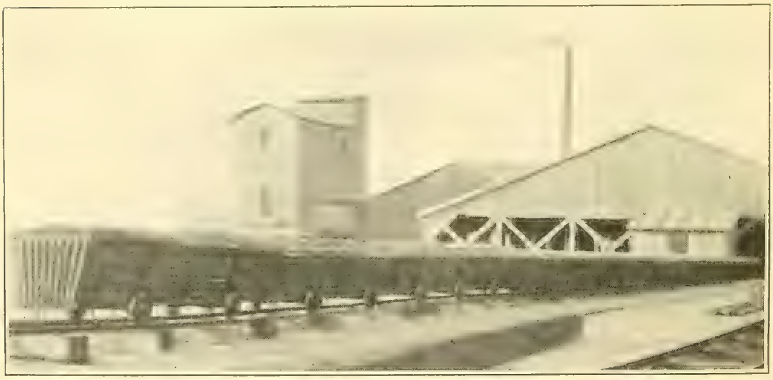


FIG. 3.—FIFTEEN CARS OF OYSTERS READY TO BE RUN INTO THE OYSTER CANNERY.

Each car holds 20 bushels, making 300 bushels in all. The capacity of this cannery is 1,500 bushels per day.

SHUCKED, ON ICE.

The process of opening an oyster and removing the "meat" is known generally as "shucking." For this purpose the oysters are conveyed to tables or stalls of various sorts in the oyster house. In the smaller establishments this is done by wheelbarrow and shovel; in the larger, the oysters are first taken to a storage room, as described above, and then let down through chutes to the individual stalls of the shuckers. Plate XXII, figure 1, represents a shucking table in one of the large oyster houses. The shucker stands on the bench before the table. The oysters fall down the slanting chute to the narrow table along the edge of which are seen the blocks on which the shucker places the oyster to open it. The shells are thrown through small chutes in the table and fall into the trough seen below, whence they are removed by a mechanical carrier.

The process of shucking requires considerable skill and strength of hand and wrist. Various methods are employed and several slightly differing styles of opening knives. Some shuckers first break off the "bill" or tip of the shell with a small hammer, insert the knife into the opening thus made, and cut the large muscle holding the shell together. Others scorn such aid, since it takes longer, and by steady pressure force the knife between the shells at the tips or the side. A skilled shucker moves his hands so rapidly the eye can hardly follow the movements. A heavy mitten is worn on the left hand, which grasps the oyster, the shell being very sharp on the edges. A fair day's shucking is 10 to 12 gallons.[a] If the oysters are in good condition, "fat," 12 gallons or a little more may be shucked. The average yield of shucked oysters from a bushel in the shell varies greatly with the condition and quality of the oysters. If the oyster meats are full and plump, they are spoken of as "fat" and the yield is greater than when "poor"; that is, the meat thin, watery, often semitransparent. A fair average yield is from 6 to 8 pints per bushel.

The "meats" are thrown into a galvanized-iron measure, which in some cases is perforated to allow the drainage of excess liquor. In some houses, however, the measures are not perforated and are partially filled with water into which the oysters are placed as shucked. When the measure is full it is taken to the measuring window and the oysters measured or weighed. The shucker sometimes receives a ticket, but in many cases the individual scores are marked up on a board by the weighing window and payment made weekly. In the smaller oyster houses the shells are thrown by the shucker to the floor and later removed in wheelbarrows. In many such houses each shucker stands in a sort of movable wooden stall placed before the table. This stall is 18 or 20 inches wide and about waist-high, being open at the rear so that the shucker may step in and out readily. Such stalls keep the accumulating piles of shells from encroaching on the space where the worker stands and also afford something against which he may lean while working. In some of the larger houses, where the shells are not thrown on the floor, the stalls are used merely to satisfy the shuckers who have

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[a] Many, however, shuck more than this amount. The author knows of one man in particular, at Hampton, Va., who opened 26 gallons a day. Since his score was marked up and pay given for this amount, this record is authentic.

become accustomed to their use in smaller places and find it less tiring to work while standing in such a stall.

Shuckers are paid by the gallon; during the winter of 1919–20 the price was $0.35 to $0.40 per gallon. Some large firms in New England employ Portuguese for shucking; in places farther south many Negroes are used for this work. Both men and women are often employed; especially is this true where colored labor is used.

After being shucked the oysters are spread out on washing tables. These are usually comparatively simple in form, as seen in Plate XXII, figure 2, are made of galvanized iron, and measure about 5 feet long by 2½ wide, the bottom being perforated to allow the water to drain off and supported on a wooden framework, as shown in the figure. Some of the larger firms use more or less elaborate washing tables, some being of the "riffle" style (Pl. XXIII, fig. 1). This consists essentially of a sloping zinc platform with ridges or elevations across it which retard the oysters as they are washed down it. The oysters receive several washings, usually in fresh water from the tap. In some States, however, the law requires that the washing be done with salt water of a certain strength in order that the oysters may not be bloated by the absorption of fresh water. In the larger houses, after receiving a preliminary washing on tables similar to that in Plate XXIII, figure 1, they are carried by a gentle stream of water down narrow runways to tanks on a lower floor (Pl. XXIV, fig. 1). These are made of galvanized iron and are about 5 feet square by 15 inches deep. Here they receive two washings, in some cases compressed air being blown from pipes through the water in which the oysters are standing. This is thought by those using it to remove more thoroughly the fine particles of dirt or bits of shell. The excess water is allowed to drain off in the last tank, and the oysters are then packed in various sorts of containers, as the tin cans in the figure, which are then packed in ice.

Usually the oysters are divided, according to size, into three grades: Standards, the smallest; Selects, the next; and Counts, or Extra Selects, the largest. The usual containers are tin cans, as shown in Plate XXIII, figure 2, of a capacity of 1, 3, or 5 gallons. The oysters are packed into these without any other liquor than that remaining after the excess has been drained off, as stated above. The cover is put on, often secured by a string passed over the top and attached to lugs on each side. The cans are packed in ice singly in boxes (Pl. XXIV, fig. 2), or several together in a barrel. Sometimes metal containers, shown at right in Plate XXIII, figure 2, are used. These are packed in a bucket carrier with ice about them. The figure also shows the 5-gallon size tin can, the bucket carrier, the short boxes containing tin cans, and a bottle container with pasteboard cap, holding one-tenth gallon. Thirty bottles are packed in a flat, wide box (see figure), with ice over their tops, and a wooden cover is nailed on.

CANNING OYSTERS.

Oysters were first canned at Baltimore in 1820, and the expression "cove oyster," which now seems synonymous with canned oysters, was originally given to the small oysters found in the coves on the west bank of Chesapeake Bay between Baltimore and the mouth of the Potomac.[a] The industry has spread rapidly in the last 20 years.

[a] Smith, H. M. Oysters: The World's Most Valuable Water Crop. National Geographic Magazine, March, 1913, p. 258. Washington.

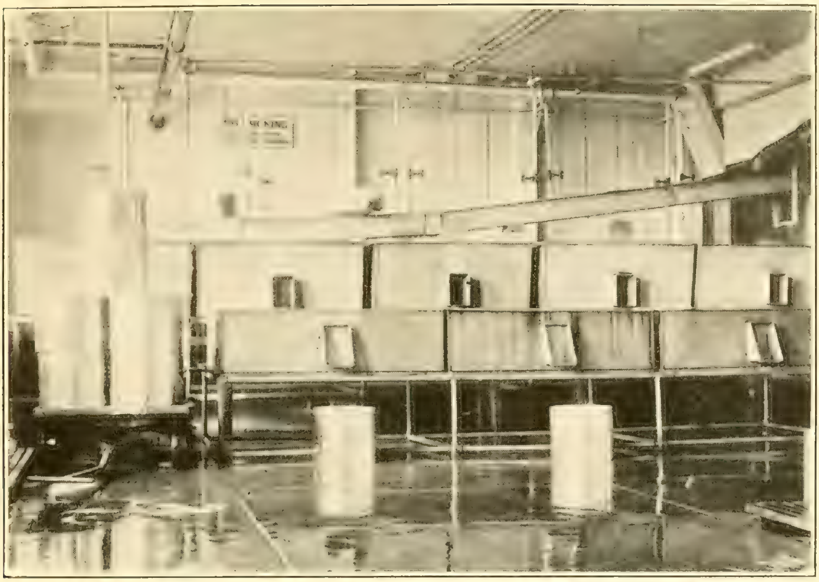

FIG. 1.—TANKS FOR WASHING SHUCKED OYSTERS.

The oyster meats come down the metal trough from the floor above. After washing they are placed in the tin cans.

FIG. 2.—PACKING FRESH OYSTER MEATS IN ICE FOR SHIPMENT.

(Photo from Prof. E. N. Cory, Maryland State University.)

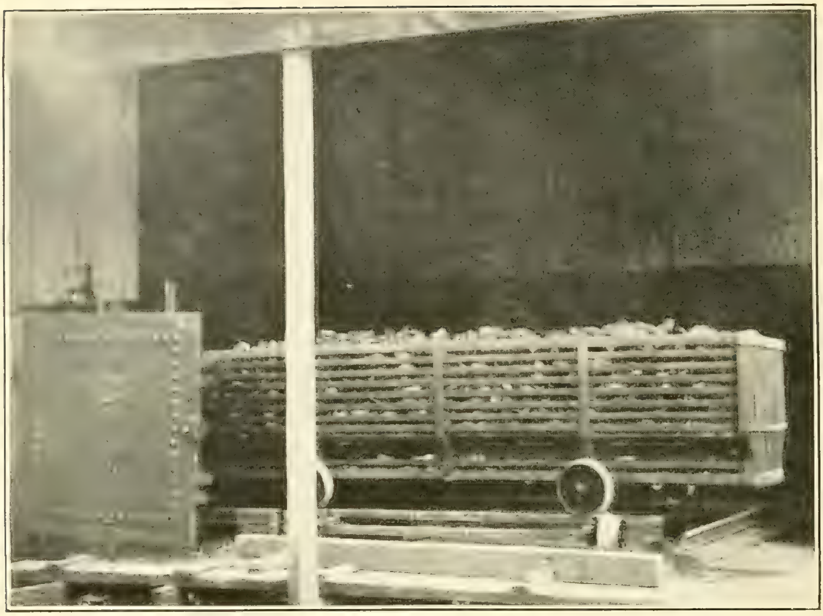

FIG. 1.—CAR OF OYSTERS READY TO BE RUN INTO STEAMER.

FIG. 2.—INTERIOR OF OYSTER CANNERY; OPENING STEAMED OYSTERS.

(Photo from Prof. E. N. Cory, Maryland State University.)

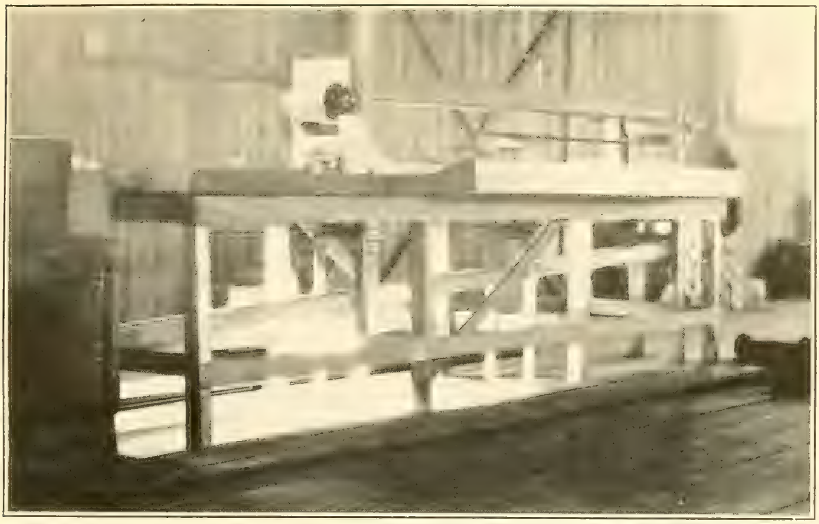

FIG. 1.—INTERIOR OF OYSTER CANNERY, SHOWING TABLE ON WHICH THE OYSTERS ARE PUT INTO THE CANS.

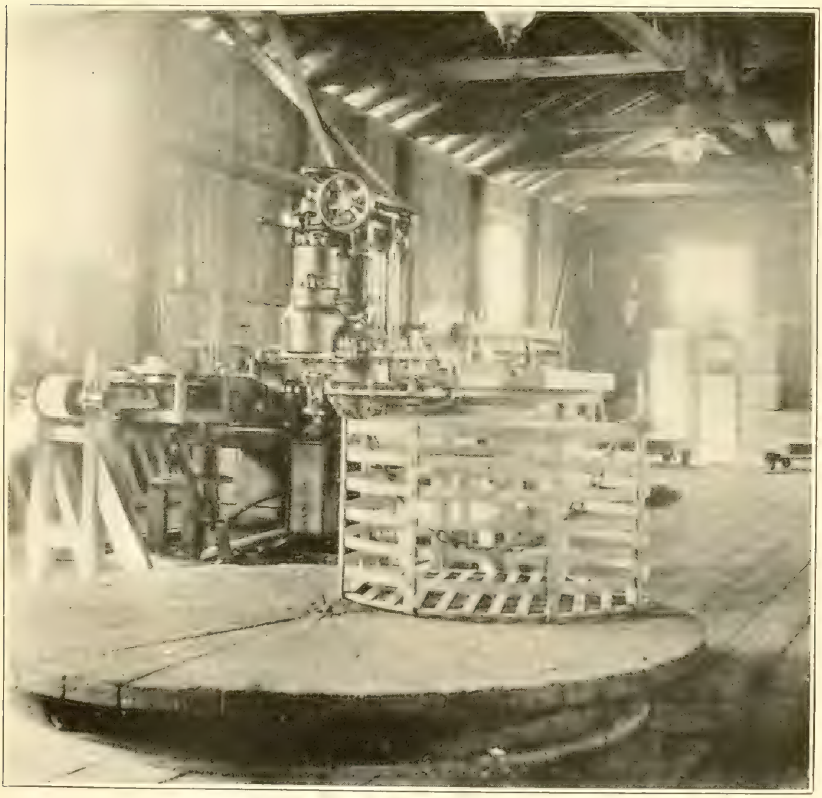

FIG. 2.—INTERIOR OF OYSTER CANNERY, SHOWING PACKING TABLE, CAPPING MACHINE, AND BASKET IN WHICH THE FILLED CANS ARE "PROCESSED."

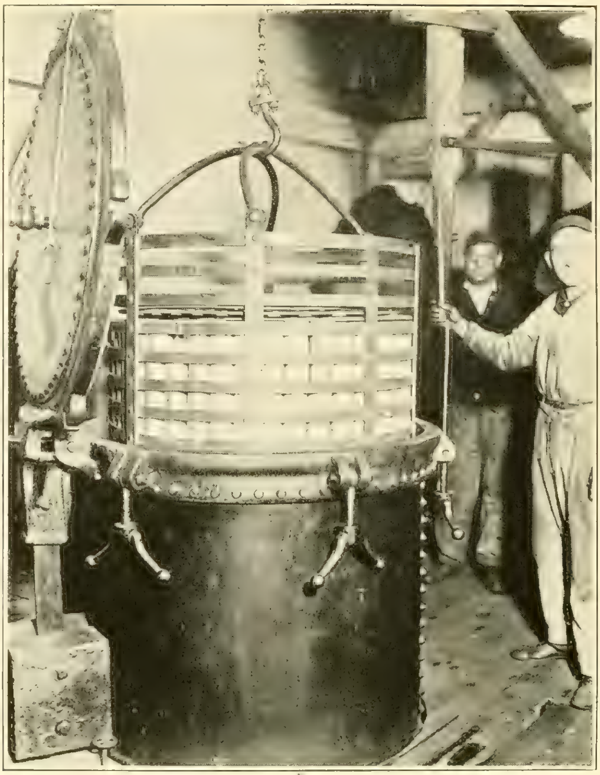

FIG. 1.—LOWERING A BASKET OF CANNED OYSTERS INTO THE KETTLE OR STEAMER TO BE "PROCESSED."

(Photo from Prof. E. N. Cory, Maryland State University.)

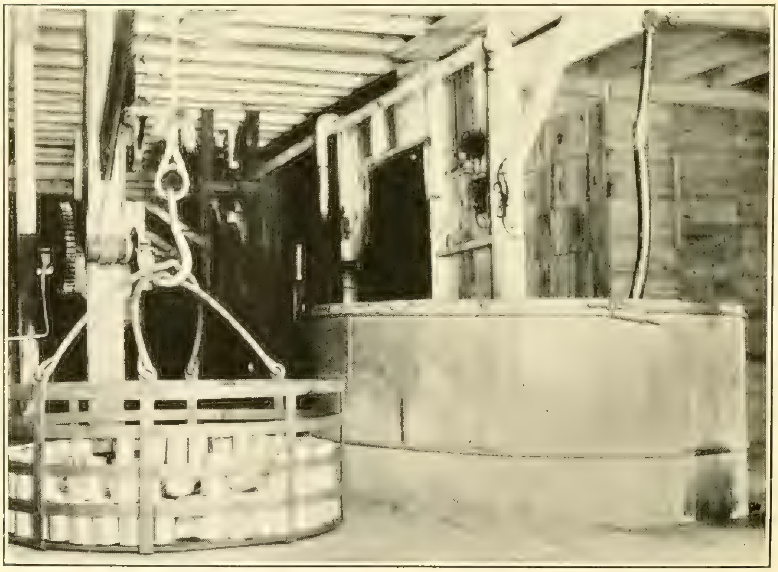

FIG. 2.—BASKET OF CANNED OYSTERS, AFTER HAVING BEEN "PROCESSED," READY TO BE LOWERED INTO THE "COOLER," AT RIGHT, WHERE RUNNING WATER IS PASSED ABOUT THE CANS.

There are now 15 canneries in Baltimore, which city still leads in number of canneries; 16 in Mississippi, 12 being at Biloxi; 18 in Georgia, 4 at Savannah, 4 in and about Brunswick, and others at smaller points; about 12 in South Carolina; 7 in North Carolina; 6 or 7 in Louisiana; and 4 or 5 in Florida.

Oyster canneries, like raw houses, are located on the water front with a wharf at which the oysters are unloaded from the boats. Plate XIV, figure 1, shows a view of an oyster cannery. At most canneries the oysters are unloaded from the boat in large tubs or buckets, as previously described, and dumped directly into cars 10 or 12 feet long, made of iron strips, basket-fashion, as in Plates XXIII and XXV. The cars are then pushed on a track into the building. Plate XXIII, figure 3, shows a line of 15 loaded cars, 20 bushels in each car, 300 bushels in all. The capacity of this particular cannery is 1,500 bushels per day.

The cars of oysters are run into rectangular iron steamers, which are often long enough to accommodate 3 cars at once. Steam is passed through for from 3 to 10 minutes, depending on the thickness of the shells. The cars are then pushed on out the other end of the steamer, sometimes being afterwards switched to another track or another room by the aid of the device shown in Plate XXV, figure 1. The short piece of track upon which the car rests is also provided with wheels, and the whole is rolled onto a lower track running at right angles to the first.

The steamed oysters are then opened directly from the cars by shuckers or openers standing alongside (Pl. XXV, fig. 2). Each worker has a metal bucket, which is suspended by a hook to the side of the car. The buckets are perforated to allow the escape of excess liquor. A knife is used, but no such skill or strength is required as is necessary in the case of raw oysters, since the steamed oysters have been killed by the process and the shells are gaping and easily separated. When a worker's bucket is filled, it is taken to the weighing window, payment being by weight, where either the money or a ticket is received. Both men and women, and often children over the legal age, do this work. In Alabama and Mississippi the workers are largely of the Slavic races. In those States many of the canning firms furnish quarters for their labor, often wood and water being included.

After being weighed, the oysters are washed two or three times with tap water in vats or on tables and then carried in buckets to the packing table (Pl. XXVI, fig. 1). The general construction of such a table is shown in the figure; it is made of wood, of convenient height, and about 12 feet long by 6 wide in the wider part and 3 in the narrower. The packing is usually done by women or girls, who stand along the sides of the table. The empty cans are supplied the packers from boxes behind them, or often a supply is placed along the edge of the table on which the oysters are piled. The packers at the farther end (see figure) of the table fill the cans almost full, placing the oysters in with the hands. They then put the cans in the rack or trough extending along over the table. The bottom of this is an endless belt which moves the cans forward until they are stopped by the crossbar at the nearer end of the trough. One packer stands on each side of the table, which is narrower here, takes the partially filled cans from the trough, one at a time, places them on the balances

seen in the figure, and fills them up until the correct weight is reached. So far in the process there is practically no liquor in the can. Cans varying in capacity from 3 to 10 ounces are usually packed. The cans are then placed on another belt, which carries them along the trough to the left under a length of perforated pipe from which hot brine drops into the cans.

The belt then takes them to the capping machine (Pl. XXVI, fig. 2), where the cover is put on. This is commonly done by the crimping process, although some firms still use the method of sealing the cover on with solder. The machine shown in the figure crimps the covers on 58 cans per minute.

After leaving the capping machine the cans are placed in large circular iron baskets, about 4 feet across, and lowered into a cylindrical metal processing tank (Pl. XXVII, fig. 1). In these tanks the cans are heated by steam to a high temperature for a short time, after which they are removed and lowered into a circular wooden tank or cooler (Pl. XXVII, fig. 2), and cooled with running water. The baskets of cans are then wheeled on tracks to the labeling and packing room (Pl. XXVIII, fig. 1), where the labels are pasted on by girls or women. The finished product is then packed in boxes, this work being done by men (Pl. XXVIII, fig. 1).

DISPOSITION OF OYSTER SHELLS.

In the larger oyster houses the shells are usually dropped by the shucker through a chute leading from the table down to a wide endless belt or a trough through which passes an endless scrape carrier. These devices carry the shells outside and up an elevator (Pl. XXIX, fig. 1) or an inclined plane (Pl. XXVIII, fig. 2). The carrier continues over the shell heap, sometimes being inclosed, and drops the shells at certain points, which may be varied as the pile grows (Pl. XXVIII, fig. 2). In other oyster houses, especially the smaller ones, the shells are removed in wheelbarrows, which are rolled on planks up the side or across the top of the pile (Pl. XXIX, fig. 2).

The shells are used for cultch, as previously described; for making lime, which is placed on soil as a fertilizer; for poultry grit; for making shell roads; and for ballast for railroad track beds. In Plate XXIX, figure 1, is shown a kiln in which the shells are being burned to make lime, a pile of the burned shells appearing in the foreground. The interior of the kiln is cone-shaped at the bottom. The shells are deposited in the kiln by the elevator, a certain amount of fine coal being mixed in as fuel. The fire in the lower part of the kiln is kept burning constantly, and the burned shells are shaken out through the grate at the bottom. The shells are then allowed to air-slake, and the lime is sold for fertilizer. The burned shells bring about $8 per ton. About a ton is put on an acre. A ton of burned shells increases in bulk to about a ton and a half during the slaking process. A ton of the slaked lime sells for $6.50.

Crushed shells are used for poultry grit. The shells are first dried in a direct-heat rotary drier similar to that used in factories where fertilizer is made from menhaden. The degree of heat applied depends entirely on the percentage of moisture in the shells; the greater the moisture the higher the temperature required. It is essential that a close observance be kept during the drying process, in order to regulate the temperature, as shells may be damaged by too much

FIG. 1.—INTERIOR OF OYSTER CANNERY; LABELING AND BOXING CANS OF OYSTERS.

(Photo from Prof. E. N. Cory, Maryland State University.)

FIG. 2.—SHELL PILE OF A LARGE OYSTER COMPANY, SHOWING CONVEYER FOR CARRYING SHELLS FROM SHUCKING TABLE TO THE PILE.

(Photo from J. S. Darling and Son.)

FIG. 1.—KILN FOR BURNING OYSTER SHELLS TO MAKE LIME, SHOWING SHELL HEAP IN BACKGROUND AND PILE OF LIME IN FOREGROUND.

(Photo from Prof. E. N. Cory, Maryland State University.)

FIG. 2.—LOADING OYSTER SHELLS INTO CAR FOR USE IN BUILDING ROADS.

heat. If the temperature is too high, the shells are likely to turn yellow, and if they are not sufficiently dried they may become soft. If they have been sheltered from the weather and are thoroughly dry the drying process may be dispensed with. After passing through the drier they are carried by a conveyer to the crusher and from there to the screen, which is usually of the revolving type and made of various-sized mesh to separate the crushed shells into several grades or sizes.

In Plate XXIX, figure 2, shells are being loaded on cars for road making. In some cases the shells are partially crushed before being put on the roads; in other cases they are put on whole and are worn down by the traffic. Plate V, figure 1, shows shells being loaded on a scow for planting to catch set.

The shell heaps are cleaned up annually. Most of the shells are used for one of the above purposes. The shell piles shown in the figures convey but a faint notion of the actual vast bulk of the oyster crop taken annually from the waters of the United States.

LEGAL REGULATIONS.

In each State in which there is an oyster industry there are certain regulations for its conduct, provided by State law and administered by officers and inspectors, appointed in nearly all cases by a State fish or oyster commissioner or president of a State conservation commission.

The regulations, while necessarily differing widely to meet the varying conditions, usually provide for a system of surveying and staking off with conspicuous buoys or markers the various beds leased or owned by the planters and the "natural" beds, the latter being those which have grown up naturally and which are open to the public. In some States, where there are many leased or privately owned beds, this surveying is very carefully attended to, and accurate maps of the oyster beds are provided. In others, especially those in which there are few or no leased beds, the surveys are poorly cared for, and no maps are kept.

The legal season in which oysters may be taken for market is usually restricted to the months of September to April, inclusive. The oyster is thus not interfered with during the spawning season, which occurs in the summer.

A cull law is usually provided by which oysters under a certain size—2½ or 3 inches generally—may not be taken except for seed, but must be thrown back on the beds from which lifted. Some States allow only sailboats and hand dredges to work on natural beds, as in Long Island Sound; some forbid dredging of any sort, all oysters being taken with tongs; some allow dredging only on leased beds; some, only in water of a certain depth; and some allow engine-driven dredges to be used on boats propelled by sails.

In most States only a legal resident may take oysters from the waters, and a license fee must usually be paid. In some cases oysters can not be shipped from the State in the shell, except for seed. This compels the establishment of oyster houses within the State and the retention of capital in that State. In others, as Louisiana, the oysters may be shipped out in the shell, but a tax per bushel must be

paid to the State by the shipper. Some States require no license fee, but the dealer pays a tax per bushel or gallon for oysters sold. This nominally throws the tax on the dealer instead of the oysterman.

Most States make provision for leasing bottoms for the cultivation of oysters at a small rental, $0.25 to $1 or $2 per acre, for a term of years, the number of acres per person being limited. Provision is usually made that the natural beds may not be leased, but must be left open to the public. In some of the southern States there is very little interest in leasing beds, there being sufficient oysters found on the natural beds. In such States there is little or no planting done, except a limited amount by the State in the effort to build up certain natural beds.

The health authorities of most of the States provide certain regulations requiring that oyster beds be located at safe distances from sources of contamination, such as sewers, etc., and that oysters must pass certain rigid inspection tests for bacterial content before being placed on the market. The Federal Government also inspects oysters which enter into interstate commerce.

There are many other minor regulations peculiar to the different States and growing out of special conditions prevailing in each. The details of these may be secured from the State shellfish commissions of the various States.

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1907. Survey of oyster bottoms in Matagorda Bay, Tex. Document 610, U. S. Bureau of Fisheries, 86 pp., 13 pls., 1 chart. Washington.
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ALASKA FISHERIES AND FUR INDUSTRIES IN 1919

By Ward T. Bower
Agent, Alaska Service

Appendix IX to the Report of the U. S. Commissioner of Fisheries for 1919

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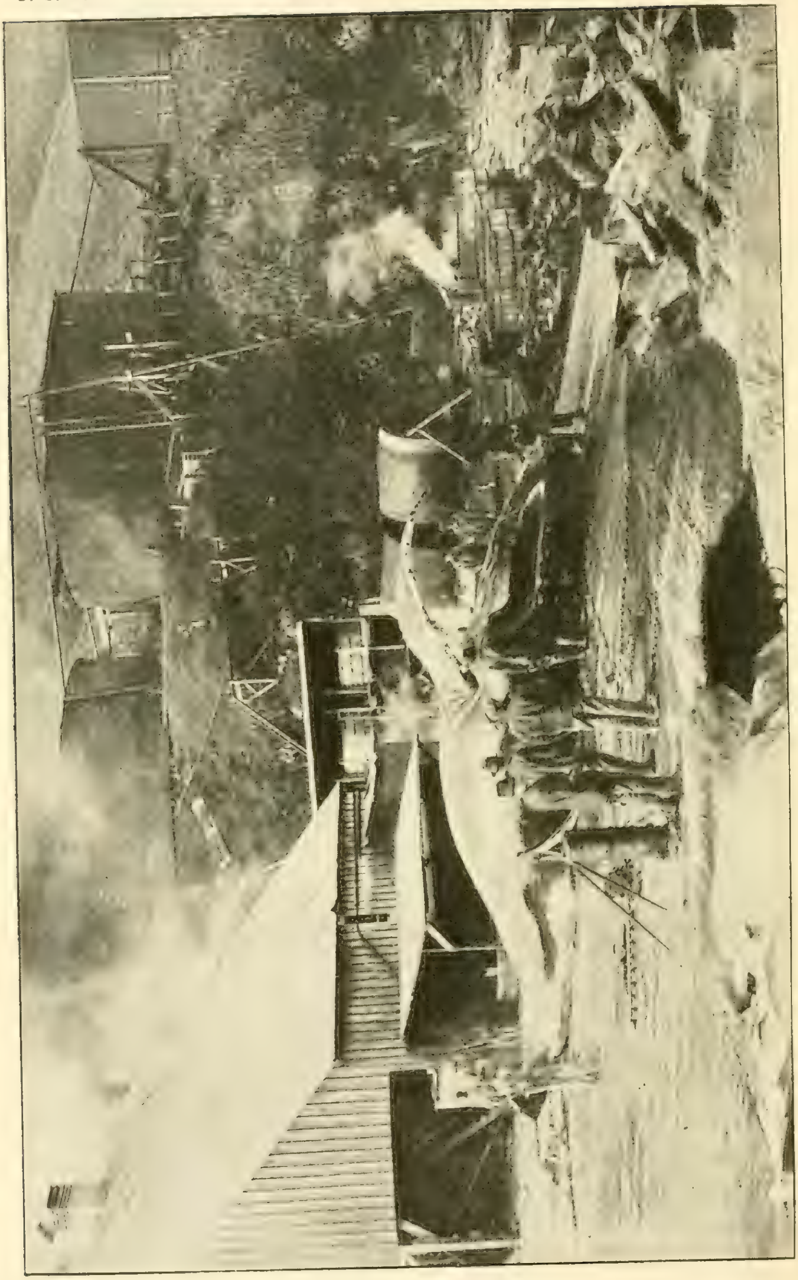
SPECIAL INVESTIGATION OF SALMON FISHERY IN CENTRAL AND WESTERN ALASKA.



SHORE WHALING STATION, AKUTAN, ALASKA.

ALASKA FISHERIES AND FUR INDUSTRIES IN 1919.

By Ward T. Bower, *Agent, Alaska Service.*

INTRODUCTION.

The activities of the Bureau in Alaska, administered through the Alaska service, paralleled in large degree operations of previous years. There were some notable expansions, however, along certain lines of the work. In this connection mention may be made of the additional attention given to patrol of the fishing grounds for the purpose of enforcing the laws and regulations. Through the detail of certain vessels, the Navy Department cooperated and aided materially in this phase of the work. The number of stream watchmen to enforce the fishery laws at certain important centers was augmented. The success attending this line of work in 1918 warranted its expansion and further application in 1919.

Another phase of the work was the collection and compilation in systematic form of detailed statistics of the various fisheries of Alaska. The annual census of salmon ascending Wood River for spawning was taken. A special investigation of the salmon fishery in central and western Alaska and one of various problems in connection with the Copper River fishery were made. Following hearings held by the Bureau at Seattle in November, 1919, salmon-fishing operations were made subject to an order issued by the Secretary of Commerce under date of December 23, 1919, applicable to most of the salmon streams in Alaska.

The work of indicating by means of markers the areas within which commercial fishing operations are limited or prohibited received considerable attention in 1919. A few markers had been put in place in previous years, but recent departmental orders have increased greatly the number of localities in which fishing operations are limited or prohibited; this means that much additional work in marking stream mouths must be undertaken as soon as possible.

Inspections of the private hatcheries operated in accordance with the act of June 26, 1906, were made. Hatchery operations under the division of fish culture were carried on at the two principal stations of the Bureau located at Afognak and McDonald Lake, the latter formerly having been designated as the Yes Bay station.

The scope and magnitude of the work in connection with the fur-seal fisheries was in keeping with that of 1918 when regular commercial sealing operations on a considerable scale were resumed. The take of fur-seal skins at the Pribilof Islands in 1919 aggregated 27,821 pelts, having an estimated value of about $2,000,000. A census of the fur-seal herd was made and a special investigation was conducted with a view to developing, if possible, improved

methods of taking and curing sealskins. The by-products plant erected on St. Paul Island in 1918 for the reduction of seal carcasses into fertilizer and oil was operated rather experimentally in 1919; it will be operated along more extensive lines in 1920.

While the natives of the Pribilofs make return to the Government in services for supplies of food, clothing, fuel, and shelter furnished them, it is necessary that the purchasing, transportation, and distribution of the major part of such supplies be attended to by the Bureau. In the matter of transportation in 1919, the Bureau received great assistance from the Navy Department, also from the Coast Guard. Acknowledgment is hereby made of the courtesies thus afforded.

The enforcement of the law for the protection of fur-bearing animals throughout Alaska received attention. In addition, the collection and compilation of statistics in regard to shipments of furs from Alaska by individuals and companies and the leasing of certain islands in Alaska for fur-farming purposes received appropriate attention.

Two sales at public auction of sealskins and one of fox pelts, taken on the Pribilof Islands, were held at St. Louis in 1919 by the selling agents of the Bureau.

The author of this report is greatly indebted to Assistant Agent E. M. Ball for compilation of statistics of the fisheries and preparation of accompanying text. Acknowledgment is also made to H. D. Aller for assistance in the preparation of text for the section regarding the Pribilof Islands, and to H. J. Christoffers for work on statistics regarding the seal herd.

REGULAR EMPLOYEES, ALASKA SERVICE.

During the year 1919 the following regular employees have been identified with the Alaska service of the Bureau:

REGULAR EMPLOYEES IDENTIFIED WITH THE ALASKA SERVICE IN 1919.

Name.	Position.	Headquarters or chief place of duty.
Ward T. Bower	Chief agent	Washington, D. C.
Edward M. Ball	Assistant agent	Cordova.
Harry J. Christoffers	do	Seattle.
Ernest P. Walker	Inspector	Juneau. (Resigned Dec. 15, 1919.)
Calvin F. Townsend	do	Fairbanks. (Promoted Dec. 20, 1919, from assistant agent.)
Shirley A. Baker	Assistant agent	Dillingham. (Reinstated Feb. 20, 1919, after military duty. Promoted Dec. 20, 1919, from warden.)
Harry C. Fassett	Agent and caretaker	St. Paul Island. (Resigned Aug. 15, 1919.)
A. H. Proctor	do	St. Paul and St. George Islands.
Charles E. Crompton	do	St. George Island. (Promoted Aug. 16, from school-teacher, St. George Island.)
Henry D. Aller	Storekeeper	St. George and St. Paul Islands.
G. Dallas Hanna	do	St. Paul Island.
Henry H. Stromberger	Physician	St. Paul Island. (Resigned July 5, 1919.)
Charles E. Johnson	do	St. George Island. (Resigned July 15, 1919.)
Frank H. Gunn	do	St. Paul Island. (Appointed July 6, 1919. Services discontinued Nov. 1, 1919.)
John J. Richstein	do	St. Paul Island. (Appointed Nov. 6, 1919.)
William M. Murphy	do	St. George Island. (Appointed July 27, 1919.)
Herschel Silverstone	Assistant to agent	St. Paul Island. (Appointed Aug. 12, 1919.)
George Haley	School-teacher	St. Paul Island.
Cora Giles Haley	do	St. Paul Island. (Resigned Sept. 30, 1919.)
Lois L. Proctor	do	St. Paul Island. (Appointed Oct. 1, 1919.)

REGULAR EMPLOYEES IDENTIFIED WITH THE ALASKA SERVICE IN 1919—Continued.

Name.	Position.	Headquarters or chief place of duty.
Edward C. Johnston	School-teacher	St. George Island. (Appointed Aug. 16, 1919.)
Henry C. Scudder	Warden	Juneau. (Reinstated Jan. 1, 1919, after military duty.)
Fred H. Gray	do	Wrangell.
Christian L. Larson	do	Chicken. (Resigned June 30, 1919.)
Lemuel G. Wingard	do	Naknek.
Philip R. Hough	do	Juneau. (Appointed Apr. 15, 1919.)
Michael J. O'Connor	do	Haines.
Hans Bierd	Master steamer Roosevelt	Seattle. (Resigned June 18, 1919.)
Edwin Hofstad	Master steamer Osprey	Cordova.
Jesse L. Nevill	Master patrol vessel	Auklet.
George Naud	do	Murre.
Albert K. Brown	Clerk	Washington, D. C.
Mary S. Haines	do	Do.
William P. Rasin	do	Do.
Marguerite McBride	do	Do.
E. Elaine Bell	do	Seattle.
Gladys M. Gamlen	do	Do.

REGULAR EMPLOYEES AT GOVERNMENT HATCHERIES IN ALASKA IN 1919.

Location and name.	Position.
Afognak:	
Edwin Wentworth	Superintendent.
Harry J. Heuver	Foreman.
Russell Noyes	Fish-culturist.
Fred R. Lucas	Do.
Albert L. Carlton	Apprentice fish-culturist. (Transferred Nov. 15, 1919, to McDonald Lake station.)
Alfred Nelson	Apprentice fish-culturist.
William M. McFarland	Apprentice fish-culturist. (Promoted Jan. 27, 1919, from apprentice fish-culturist, Clackamas, Oreg. Transferred July 15, 1919, to Puget Sound stations.)
Thomas H. Morton	Apprentice fish-culturist. (Transferred Sept. 15, 1919, from McDonald Lake station.)
F. J. Stewart	Cook.
McDonald Lake:	
C. H. Van Atta	Superintendent.
Calvin D. Ryan	Foreman.
C. N. Blystad	Fish-culturist. (Promoted Feb. 28, 1919, to scientific assistant, Homer, Minn.)
William L. Stiles, jr	Fish-culturist. (Promoted May 16, 1919, from apprentice fish-culturist, Baird, Calif.)
J. H. Tierney	Fish-culturist. (Resigned Oct. 20, 1919.)
Albert L. Carlton	Fish-culturist. (Promoted Nov. 16, 1919, from apprentice fish-culturist. Afognak, Alaska.)
William A. Cagle	Apprentice fish-culturist. (Transferred May 15, 1919, to apprentice fish-culturist, Clackamas, Oreg.)
Clarence Houts	Apprentice fish-culturist. (Appointed Aug. 1, 1919.)
William O. C. Owen	Apprentice fish-culturist. (Transferred Mar. 15, 1919, from fish-culturist, Leadville, Colo. Resigned Apr. 30, 1919.)
Thomas H. Morton	Apprentice fish-culturist. (Reinstated June 20, 1919. Transferred Sept. 14, 1919, to apprentice fish-culturist, Afognak, Alaska.)
Everett V. Campbell	Apprentice fish-culturist. (Appointed Sept. 27, 1919.)
Hugh Coppinger	Apprentice fish-culturist. (Appointed Jan. 27, 1919. Resigned Sept. 30, 1919.)
M. T. Tierney	Cook. (Resigned Oct. 6, 1919.)
Stella A. Campbell	Cook. (Appointed Oct. 7, 1919.)

FISHERY INDUSTRIES.

As in corresponding reports for previous years, the Territory of Alaska is here considered in the three coastal geographic sections generally recognized as follows: Southeast Alaska, embracing all that narrow strip of mainland and the numerous adjacent islands from Portland Canal northwestward to and including Yakutat Bay; central Alaska, the region on the Pacific from Yakutat Bay westward, including Prince William Sound, Cook Inlet, and the southern coast of the Alaska Peninsula, to Unimak Pass; and western Alaska, the north shore of the Alaska Peninsula, including the Aleutian Islands and Bristol Bay and the Kuskokwim and Yukon Rivers.

Detailed reports and statistical tables dealing with the various fishery industries are presented herewith, and there are also given the important features of certain subjects which were the objects of special investigation or inquiry.

WATERS CLOSED TO COMMERCIAL FISHING.

Section 6 of the act approved June 26, 1906, for the protection and regulation of the fisheries of Alaska, is as follows:

SEC. 6. That the Secretary of Commerce may, in his discretion, set aside any streams or lakes as preserves for spawning grounds, in which fishing may be limited or entirely prohibited; and when, in his judgment, the results of fishing operations in any stream, or off the mouth thereof, indicate that the number of salmon taken is larger than the natural production of salmon in such stream, he is authorized to establish close seasons or to limit or prohibit fishing entirely for one year or more within such stream or within five hundred yards of the mouth thereof, so as to permit salmon to increase: *Provided, however*, That such power shall be exercised only after all persons interested shall be given a hearing, of which due notice must be given by publication; and where the interested parties are known to the Department they shall be personally notified by a notice mailed not less than thirty days previous to such hearing. No order made under this section shall be effective before the next calendar year after same is made: *And provided further*, That such limitations and prohibitions shall not apply to those engaged in catching salmon who keep such streams fully stocked with salmon by artificial propagation.

Pursuant to the provisions of this section, action was taken in 1919 in regard to the waters of southeast and central Alaska, and also in regard to certain waters tributary to Bering Sea.

Under date of September 24, 1919, announcement was made of a hearing to be held in respect to the district extending from Cape Spencer on the east to Cape Sarichef on the west, and northward on Bering Sea to Cape Newenham. The text of the announcement was as follows:

It having been recommended that the Secretary of Commerce set aside all lakes and streams as preserves for spawning grounds and limit or prohibit commercial fishing for salmon and other commercial fishing in the prosecution of which salmon are taken or injured in all such streams and lakes and all waters tributary thereto and within 500 yards of the mouths of such streams, in all waters of Alaska flowing into the Pacific Ocean between the longitude of Cape Spencer on the east and the longitude of Cape Sarichef on the west; also in all such waters tributary to Bering Sea between Cape Sarichef and Cape Newenham, notice is hereby given, under the provisions of section 6 of the act of Congress approved June 26, 1906, entitled "An act

for the protection and regulation of the fisheries of Alaska," that a hearing to determine the advisability of limiting or prohibiting fishing operations in the above-described waters will be held at the office of the Bureau of Fisheries, 1217 L. C. Smith Building, Seattle, Wash., on November 20, 1919, at 10 o'clock a. m., at which time and place all persons interested will be heard.

Under date of October 24, 1919, announcement was made of a hearing to consider the desirability of amending the order of December 21, 1918, affecting waters of southeast Alaska east of the longitude of Cape Spencer. The text of the announcement is as follows:

It having been recommended that the Secretary of Commerce amend the order of December 21, 1918, effective January 1, 1919, limiting and prohibiting fishing for salmon, or other fishing in the prosecution of which salmon are taken or injured, in certain waters of southeastern Alaska east of the longitude of Cape Spencer, to include all streams more than 500 feet in width, notice is hereby given, under the provisions of section 6 of the act of Congress approved June 26, 1906, entitled "An act for the protection and regulation of the fisheries of Alaska," that a hearing to determine the advisability of further limiting fishery operations, or of modifying existing limitations on such operations, in the waters in question will be held at the office of the Bureau of Fisheries, 1217 L. C. Smith Building, Seattle, Wash., on November 25, 1919, at 10 o'clock a. m., at which time and place all persons interested will be heard.

Following the two hearings on November 20 and 25, 1919, the Department, under date of December 23, 1919, promulgated the following order:

Hearings having been given at Seattle, Wash., November 20, 1919, and November 25, 1919, respectively, after due notice in accordance with law, for the purpose of determining the advisability of limiting or prohibiting fishing in certain waters in Alaska, and to amend or modify the order of December 21, 1918, and all persons having had full opportunity to be heard, it is hereby ordered, by virtue of the authority vested in me by section 6 of "An act for the protection and regulation of the fisheries of Alaska," approved June 26, 1906, that until further notice all fishing for salmon, or other fishing in the prosecution of which salmon are taken or injured, in all hereinafter-described waters of Alaska be and is hereby made subject to the following limitations and prohibitions in addition to the general restrictions already applicable by virtue of existing laws and regulations:

1. Waters east of the longitude of Cape Spencer.

(*a*) All fishing is prohibited in all salmon streams and their tributaries and lakes.

(*b*) All fishing, except with purse seines and drift gill nets, is prohibited within 500 yards of the mouths of all salmon streams.

(*c*) All fishing with purse seines and drift gill nets is prohibited within 200 yards of the mouths of all salmon streams, and all fishing with purse seines and drift gill nets as well as with all other apparatus is prohibited within 500 yards of the mouths of Chilkat River, Chilkoot River, Anan Creek, Hetta Creek, Sockeye Creek, and Naha Stream.

2. All fishing is prohibited in all salmon streams, their tributaries and lakes, and within 500 yards of the mouths of such streams, flowing into the Pacific Ocean or Bering Sea between Cape Spencer and Cape Newenham, except as follows:

(*a*) Fishing is permitted in Bering River below a line extending at right angles across Bering River from a point approximately 800 feet northwesterly from the mouth of Gandil River.

(*b*) Fishing is permitted in Copper River and its tributaries in accordance with the terms of the order promulgated December 20, 1918, which order is continued in full force.

(*c*) Fishing is permitted at Karluk beyond the zone 100 yards outside the mouth of Karluk River where it breaks through Karluk Spit into Shelikof Strait.

(*d*) Fishing is permitted in Ugashik River below a line extending at right angles across the Ugashik 500 yards below the mouth of King Salmon River.

3. The driving of salmon downstream and the causing of salmon to go outside the protected area at the mouth of any salmon stream are expressly prohibited.

4. This order does not apply to persons taking salmon with rod, hand line, or spear for their personal or family use and not for sale or barter.

5. The waters of the Afognak Reservation are covered by Presidential proclamation of December 24, 1892, and the regulations promulgated by authority thereof are not modified or affected by this order, but remain in full force.

6. All previous orders of the Secretary of Commerce imposing limitations or prohibitions upon fishing in the waters covered by this order, except as hereinbefore indicated, are hereby superseded.

7. This order became effective January 1, 1920.

Limitations and prohibitions upon fishing are applicable in the waters of the Yukon and Copper Rivers by virtue of previous orders of the Secretary of Commerce. Limitations have been placed upon fishing by Executive order or proclamation in the following additional waters: Afognak Reservation, Aleutian Islands Reservation, Yes Bay and Stream, and the Annette Island Fishery Reserve.

STREAM IMPROVEMENT.

In recent years the Bureau has done some work in regard to the removal of obstructions and natural barriers from streams in Alaska to permit breeding salmon to reach previously inaccessible spawning grounds. Not much was done along this line in 1919, as there was a shortage of funds and personnel, and for the further reason that the Alaska Legislature had provided for a Territorial fish commission, one of the functions of which was the removal of natural obstructions from salmon streams. The Bureau has been glad to relinquish this phase of the work to the Territory. It is hoped that efforts may be pushed vigorously, as there is a splendid field which promises big returns in the way of conserving the supply of salmon. Employees of the Bureau have been directed to cooperate with the Territorial fish commission in these operations.

STREAM WATCHMEN.

Supplemental to the patrol work of the Bureau as carried on by the regular employees stationed in Alaska, temporary employment was given to a few men in the southeast and central districts as stream watchmen. The general plan was to place these men at certain important streams or localities during the salmon season to prevent encroachments upon areas closed to commercial fishing. As far as means permitted this was done in 1919. The greatest merit of the service lies in the prevention of raids on the schools of salmon as they congregate at the mouths of the streams. It will grow in value in proportion to the number of streams which may be thus guarded.

Stream watchmen were employed in southeast and central Alaska as follows: In southeast Alaska, A. Burks Summers, Cyrus B. Johnson, Ernest F. Goodner, C. C. Combs, Edward Fay, Walter Campen, Lester Campen, George W. Mock, and E. J. Hunsacker; in central Alaska, Kenneth C. Cole on Prince William Sound and Cook Inlet, Newt Casperson at Miles Lake and Abercrombie Canyon, Kristof Lahz at Eshamy Bay, W. E. Baumann at Afognak, and John J. Folstad at Karluk. In addition, Joseph A. Bourke, a Territorial officer, detailed through courtesy of Governor Riggs, assisted in the work on the Copper River and Prince William Sound.

The fifteen persons above named, together with the regular employees of the Bureau, constituted a larger force than had been engaged any season previously in fishery protective work in Alaska.

ALASKA FISHERY INTELLIGENCE SERVICE.

This service, inaugurated in 1917, whereby the prices paid for fish at Seattle and Ketchikan were supplied by telegraph to a number of towns in Alaska, was continued through the year 1919. Expressions of appreciation have been received, and the information is believed to be of value to the fishermen. It is planned to continue the service.

FISHERY PATROL.

BUREAU PATROL BOATS.

A successful patrol of the waters of Alaska in the interest of the fisheries is contingent upon the ability of the officers of the law to reach any region at any time. Suitable boats are the means by which such work can be accomplished. To meet the situation, the Bureau maintains and operates a small fleet of vessels in Alaska, admittedly inadequate for the work, but being enlarged as rapidly as possible with funds available. This fleet is supplemented by the charter of privately owned boats for occasional trips and short periods.

Of the Bureau's vessels, the steamer *Osprey* has long been the mainstay of patrol work in southeast Alaska. In June, it was transferred to the central district, where the growing needs of the service demanded the presence of such a boat.

The *Murre* and *Auklet* remained in the southeast district and were regularly employed during the active fishing season from June to October. The *Puffin*, formerly attached to the *Roosevelt* as ship's launch, rendered some service in the vicinity of Juneau and the Taku River. It was sent north from Seattle under its own power early in July, but owing to engine trouble did not reach Ketchikan until almost a month later and then only by shipment on a freight steamer from a Canadian port. After certain alterations are made the *Puffin* can be used to advantage in stream-protective work.

Three small launches were chartered for a few days in central Alaska for patrol work in the Copper River and Cook Inlet sections.

The *Swan* was used on the Yukon River, particularly in patrolling the waters of the delta where Yukon commercial fishing was centered in 1919. Assistant Agent Townsend covered about 4,000 miles with the *Swan*, from Fairbanks to the mouth and return to Nenana, where the vessel was hauled out for the winter.

Under authority of Executive order of May 24, 1919, in regard to the disposition of vessels no longer needed by the Navy Department, three vessels which had been used as scout patrols off the New England coast, were transferred to the Bureau for service in Alaskan waters. Two of these vessels, the *Cobra* (S. P. 626) and the *Calypso* (S. P. 632), were turned over to the Bureau at Quincy, Mass., in July. In October the *Wachusetts* (S. P. 548) was also secured at the same place. All of these vessels were towed by the Bureau's steamer *Phalarope* to the Woods Hole station. Subsequently the *Cobra* and *Calypso*, renamed *Petrel* and *Merganser*, respectively, were towed by the *Phalarope* to the Norfolk Navy Yard, where on October 3 they were placed aboard the U. S. S. *Neptune* for transportation to the Pacific coast. The vessels reached the Puget Sound Navy Yard early in

1920. The *Wachusetts*, since named the *Fulmar*, is still at the Woods Hole station.

The *Petrel* was built in 1917, is 53 feet in length, and is equipped with a 350–400-horsepower Dusenberg motor, which is said to give a maximum speed of 25 miles. Fuel capacity is 600 gallons. The vessel originally cost $14,000.

The *Merganser*, which was built in 1909, is 43 feet in length, and is equipped with a 20-horsepower Alco engine. Fuel capacity is 100 gallons and speed 9 miles an hour.

The *Fulmar* was built in 1914 and is 101 feet in length and 17 feet in breadth. It is equipped with a 120-horsepower Nlsco Diesel engine. The vessel measures 65 tons gross burden.

It is planned to detail the *Petrel* and *Merganser* for duty in southeastern Alaska, and the *Fulmar* for service in the more exposed waters of central Alaska. It will be necessary to make alterations on all of these vessels before they are ready for service. The work will be undertaken as soon as funds are available. It is anticipated that the *Petrel* and *Merganser* will be available for duty before the end of the fishing season of 1920.

MILES CRUISED AND COST OF OPERATION OF CERTAIN FISHERY PATROL BOATS OF THE BUREAU.

Name.	Miles cruised.	Cost of fuel.	Cost of repairs, etc.	Subsistence of crew.	Total cost.
Auklet [a]	6,444	$812.10	$1,404.41	$344.50	$2,561.01
Murre [a]	5,436	782.65	1,261.75	336.60	2,381.00
Osprey [b]	4,303	2,188.60	1,354 03	1,027.20	4,569.83
Total	16,183	3,783.35	4,020.19	1,708.30	9,511.84

[a] In commission about 6 months. [b] In commission about 10 months.

NAVAL VESSELS.

In 1918 the National Council of Defense through its representatives in Juneau requested the Secretary of the Navy to send vessels to Alaska to assist in enforcing the fishery laws of the Territory. In the same year, after an extended cruise in Alaskan waters, Lieut. Commander Driggs, United States Navy, commanding officer of the U. S. S. *Brutus*, in a report to the Secretary of the Navy, pointed out that wastes of salmon had occurred in western Alaska, particularly Bristol Bay, and that the present law was inadequate to protect the fisheries properly. To meet the situation as thus represented the Secretary of the Navy ordered the U. S. S. *Vicksburg* and two submarine chasers to Alaska in 1919 to patrol the fishing grounds during the period of greatest fishing activity. The *Vicksburg* with subchasers *No. 309* and *No. 310* proceeded to Juneau early in the season. Toward the end of May subchaser *No. 309* was detailed to patrol duty in southeast Alaska, while subchaser *No. 310* accompanied the *Vicksburg* to Cordova for similar duty in central Alaska, arriving there shortly after the 1st of June.

In accordance with arrangements made with the Navy Department for the placing of fisheries agents on these boats, Warden H. C. Scudder, of the Bureau's force in southeast Alaska, was detailed to

the *Vicksburg* and was transported to Ikatan, where he remained while the vessel went on to Bristol Bay. The *Vicksburg's* stay in western Alaska was comparatively short, due to the small run of salmon and the early closing of the canneries. The return voyage began early in July and Mr. Scudder was picked up and brought back to Juneau. En route the *Vicksburg* called at Cordova on July 18 to convoy subchaser *No. 310* back to Juneau. Subchaser *No. 310*, which was detailed to central Alaska, made one short inspection trip around Prince William Sound and into Valdez for the Bureau and afforded transportation to Assistant Agent E. M. Ball to Kodiak, but from there was at once ordered to Yakutat in the matter of a disturbance over fishing rights of the Indians and was of no further assistance to the Bureau in the central district. Representatives of the Bureau in southeast Alaska were on a number of occasions afforded transportation on the subchasers *No. 309* and *No. 294*. The latter replaced *No. 309* late in July. The U. S. S. *Marblehead* was also in the southeast district for a short time in connection with the fish-trap piracy situation.

VIOLATIONS OF FISHERY LAWS AND REGULATIONS.

The case against the Alaska Pacific Fisheries, which company was indicted in October, 1918, on 15 counts for failing to close properly several of its traps during weekly close seasons in July and August, 1918, was called for trial at Juneau on June 14, 1919. Motion by the defense for a continuance being denied, evidence was presented by the Government on five counts of the indictment in respect to traps at Grindall Point, Cleveland Peninsula, South Vallenar Point, Stone Rock Bay, and Cape Chacon. The jury returned a verdict of guilty. The court thereupon imposed a fine of $1,000 for each of the five counts, which with the costs of $177.20 made a total of $5,177.20 paid by the Alaska Pacific Fisheries for the unlawful operation of the traps in question. The remaining 10 counts were dismissed owing to the absence of an important witness for the Government.

Another case against the Alaska Pacific Fisheries involving the construction in 1917 of a floating trap within the prohibited lateral distance of a trap at Village Point, Icy Strait, belonging to the Thlinket Packing Co., was also brought to trial on June 14, 1919, after many postponements. The company, being denied a further continuance, pleaded guilty to the charge and paid a fine of $100 plus costs amounting to $753.80.

During the weekly close season on August 23, 1919, a trap of the Alaska Pacific Fisheries on Chichagoff Island was found in full fishing order. Complaint being entered before the United States commissioner at Juneau on September 15, the company pleaded guilty and was fined $200 and costs.

On September 22, 1919, Hugh Whitelaw and Gus Starkloff were found fishing in Staney Creek on the west coast of Prince of Wales Island. Whitelaw was brought before the United States commissioner at Ketchikan on October 23, when he pleaded guilty and paid a fine of $10 and costs of $3.13. Starkloff was indicted but not apprehended during the year.

On October 15, 1919, a complaint was filed in the United States commissioner's court at Juneau, charging the Deep Sea Salmon Co. with the operation of two floating traps on the west shore of Port Althorp on Sunday, August 24, 1919. The company pleaded guilty and paid a fine of $400 and costs.

The grand jury sitting at Juneau in September, 1919, indicted William Brady, Pat Brady, George Paul, and Sam Goldstine for unlawful fishing with a seine in a creek flowing into Gambier Bay. On December 9 the case was dismissed by the court, as it was shown that the fishing was on the tide flats outside the stream.

The Petersburg Packing Corporation was fined $200 and costs in the United States commissioner's court at Ketchikan on October 23 for failure to close properly its trap at Point Colpoys on Sunday, August 17, 1919.

On Sunday, August 3, a trap of the Sunny Point Packing Co. was found only partially closed. A true bill was returned against the company on October 23 at Ketchikan, to which a plea of guilty was entered on October 29. A fine of $100 and costs was imposed.

During the weekly close season on the night of August 2 a trap of the Anacortes Fisheries Co. at Lemesurier Point was found fishing. The matter was reported to the grand jury at Juneau, which on September 15 indicted the company and both trap watchmen. The case was tried at Ketchikan on October 20 and resulted in a conviction. A fine of $150 was imposed against the company and $25 against each of the two watchmen.

An indictment was returned at Juneau on September 15 against the Alaska Herring & Sardine Co. for constructing a trap in Wilson Cove, Chatham Strait, within 500 yards of the mouth of a stream, this being contrary to the closing order of December 21, 1918. The case was dismissed upon transfer to Ketchikan, the company agreeing not to reconstruct the trap.

On July 30 Pete Knutsen and Ole Knutsen were fishing in Petersburg Creek with a gill net set almost entirely across the stream. They were indicted at Juneau September 15 on two counts, one for fishing within the creek and one for fishing in the estuary at the mouth of the creek. The case was tried at Ketchikan and resulted in a conviction on the second count. On November 15, 1919, a motion for a new trial was filed.

Complaint was filed on October 10 in the United States commissioner's court at Ketchikan against Chris Selness, an alien, for fishing in violation of the law. In the course of the trial it was shown that Selness avoided the draft for military service by surrendering his declaration papers and that he was being paid wages as a fisherman at the time of the alleged unlawful fishing. The jury regarded him as a partner in the fishing business and accordingly found him guilty as charged. He was fined $500. The case was taken to the district court on appeal and set for trial at Ketchikan on October 23. After the court ruled that the defendant could fish for wages, the case was dismissed on motion of the United States attorney.

On Sunday, August 3, a fish wheel, marked "McBride & Co. No. 2," was found in operation on the Taku River. Complaint was filed before the United States commissioner at Juneau on September 10 against H. C. McBride, A. H. Humphries, and William Strong.

Humphries, appearing for all defendants, pleaded guilty and paid a fine of $100 and costs.

On September 13 William Strong was also indicted as an alien, it being alleged that he was a Canadian who had not declared his intention of becoming a citizen. This case is still pending.

On September 16 the grand jury indicted the George T. Myers Co. for fishing with a trap near Pinta Cove on Sunday, July 20. On September 17 the company pleaded guilty and was fined $250 and costs.

On September 15 the same grand jury indicted the Sanborn-Cutting Co. for fishing on Sunday, August 10, with a floating trap north of Mole Harbor on the west shore of Seymour Canal. When the case was called for trial on September 22 the company was convicted and fined $150 and costs.

Three traps belonging to P. E. Harris & Co. on the west shore of Admiralty Island were found in fishing order on Sunday, July 20. One of the same traps was also fishing during the close period on Monday, August 18. A complaint, covering four offenses, was filed against the company in the United States commissioner's court at Juneau. A plea of guilty was entered and a fine of $800 and costs was paid.

In June, 1919, Jacob Hollingstad, John Saarikoski, Kusti Joki, and Peter Peterson were accused as aliens of a violation of the act of June 14, 1906. Hollingstad, Saarikoski, and Peterson had taken out their first naturalization papers more than seven years before, but had made no subsequent attempt to attain full citizenship. Saarikoski and Joki were each fined $100 and costs, amounting to $6.20. Hollingstad, having claimed exemption from military duty as an alien, was fined $150 and costs of $9.20; Peterson pleaded guilty and was fined $100. Another alien named Dahl was also apprehended for fishing after the expiration of his first papers. Upon entering a plea of guilty at Ketchikan he was fined $5 and sentenced to purchase thrift stamps to the value of $100 before September 1.

Nels Peterson was found fishing with a gill net in Chilkat Inlet during the weekly close season on September 1. His boat and net were seized and turned over to the United States marshal. On September 10 a complaint was filed before the United States commissioner at Juneau, to which Peterson pleaded guilty; he was thereupon fined $200 and costs, which being paid, his boat and net were returned to him.

On September 10 a complaint was executed before the United States commissioner at Juneau, charging the Pacific American Fisheries with failure to close one of its traps on Chichagoff Island on July 20 and August 17, failure to close two traps on the east shore of Excursion Inlet on August 17, and further, for having constructed a trap on the east shore of Excursion Inlet within 500 yards of the mouth of a salmon stream. The company pleaded guilty to all five counts and paid a fine of $750 and costs.

On September 15 the Northwestern Fisheries Co. was fined $200 and costs for the faulty closing of a trap on the south shore of Icy Strait west of Point Augusta on Sunday, August 17.

The Astoria & Puget Sound Canning Co. was charged on September 15 in the United States commissioner's court at Juneau with not

properly closing two traps in operation on the shore of Icy Strait on July 20 and August 17, and for having constructed a trap in False Bay, Chatham Strait, within 500 yards of the mouth of a salmon stream. The company pleaded guilty and paid a fine of $600.

In answer to a complaint filed before the United States commissioner at Juneau, Libby, McNeill & Libby pleaded guilty to having failed, on July 20, to close its trap located on the south shore of Icy Strait, and paid a fine of $200 and costs.

In September the Hidden Inlet Canning Co. was indicted for constructing a trap in Peril Strait near False Island, within the prohibited distance of a salmon stream. The case had not been disposed of at the close of the year.

The cases against the Carlisle Packing Co. and the Canoe Pass Packing Co., indicted at Valdez in October, 1918, for having driven and constructed certain fishing appliances on the tide flats between Mountain Slough and Cape Whitshed on the western side of the Copper River delta, came on for trial at a term of the district court at Cordova the latter part of September, 1919. The Government alleged that the Carlisle Packing Co. had driven three fish traps along the shore indicated, and to each of them a similar appliance was constructed and attached leaving no endwise space between the two structures: and that the Canoe Pass Packing Co. had driven one such appliance. The companies set up a defense that each of these structures as thus joined constituted but a single trap. Trial by jury being waived by both companies, the testimony was heard on September 25 by District Judge Charles E. Bunnell, who found them guilty as charged in the indictment. On September 30, the Carlisle Packing Co. was fined $450, or $150 for each double trap, and the Canoe Pass Packing Co. paid a fine of $150. The costs of the trials followed the judgments in both cases.

At the Valdez term of the district court in October, 1919, the cases of the Alaska Packers Association and the Alitak Packing Co. came up on appeal from the court of the United States commissioner at Kodiak. Each company was tried at Alitak in September, 1918, for the construction of a trap on Moser Bay within the prohibited lateral distance of another trap, the two traps in controversy being owned by the companies named. Trial in the lower court resulted in a fine of $1,000 and the costs against each company. The case of the Alitak Packing Co. was tried first at Valdez and resulted in a conviction. It was fined $500, or one-half of the amount of the fine imposed at Kodiak; costs of the trials in both courts were added, amounting to $563.90. The Alaska Packers Association was acquitted, the testimony in the case clearly showing that at the time the construction of its trap was begun there was not then any other fixed fishing appliance within 600 yards laterally of its structure nor was any in process of construction. A memorandum decision was given in the Alitak case on October 24, 1919, by Judge Bunnell which, because of its peculiar interest to all operators of fish traps, is quoted here in full.

The evidence in this case as per stipulation filed for and on behalf of the United States by the district attorney and for and on behalf of the defendant corporation by its attorney of record consists of all the testimony taken before H. H. Beck, commissioner and ex-officio justice of the peace at Kodiak, Kodiak Precinct, in the case of the United States of America *v.* Alitak Packing Co., No. 563 in the lower court, and the United States of America *v.* Alaska Packers Association, No. 539 in the lower

court; also the testimony of E. M. Ball, called by the Government upon trial had in the district court. Both the Government and the defendant waive trial by jury and the defendant admits its corporate existence.

The facts in the case are easily determined. Moser Bay is an arm of Alitak Bay on the southwesterly shore of Kodiak Island. At the place where the Alaska Packers Association constructed its trap the distance from shore to shore is about 2 miles. On the 4th day of May, 1918, the Alaska Packers Association began driving a trap off the north shore of Moser Bay at a point about 3,000 feet from the shore and on a line nearly at right angles with the shore or beach line. The "heart," "pot," and "spiller" were first completed and several hundred feet of the "lead" were driven before the defendant corporation began the construction of a trap easterly from the Packers' trap. The defendant began the construction of its trap at a point about 900 feet from the shore and on a line nearly at right angles with the shore or beach line. Construction work was begun by the defendant on the 4th of June. The same general plan of construction was adopted by both the Packers and the defendant and both drove from deep water toward the shore. The defendant's trap was completed on about the 15th day of June. The Packers' trap with the exception of about 600 feet of the lead nearest the shore was completed on the 7th of June. The work was not continuous, though practically so, the witness Seaborg, "the boss trap man," testifying:

"We drove pretty much every day, that is, after the ship was discharged. That is, that when we got through with the lighter I drove a few piles, working at it every day a little."

The work of driving the last 600 feet of the "lead" was completed on the 18th of June. This 600 feet of "lead" swings to the east, toward the defendant's trap, and the shore end is about 150 feet nearer the shore end of defendant's "lead" than it would have been had it continued to the shore on the same line with the rest of the "lead." The distance between the shore end of the Packers "lead" and the shore end of the defendant's "lead" is 952 feet. The distance from the westerly side of the "pot" of defendant's trap to the "lead" of the Packers' trap calculated by a line running at right angles to the "lead" of the defendant's trap is considerably less than 600 yards.

The defendant defends on the theory that when it began the construction of its trap it was not within 100 yards endwise of any other trap or fixed fishing appliance and therefore when the Packers' "lead" was driven to a point 100 yards distant from a line drawn from the outside end of defendant's trap at right angles to defendant's "lead" and extending westerly across the course of the Packers' "lead," the Packers must cease further construction in order to keep within the provisions of section 262 of the Compiled Laws of Alaska. Section 262 provides:

"It shall be unlawful to lay or set any drift net, seine, set net, pound net, trap, or any other fishing appliance for any purpose except for purposes of fish culture, across or above the tide waters of any creek, stream, river, estuary, or lagoon, for a distance greater than one-third the width of such creek, stream, river, estuary, or lagoon, or within 100 yards outside of the mouth of any red-salmon stream where the same is less than 500 feet in width. It shall be unlawful to lay or set any seine or net of any kind within 100 yards of any other seine, net, or other fishing appliance which is being or which has been laid or set in any of the waters of Alaska, or to drive or construct any trap or any other fixed fishing appliance within 600 yards laterally or within 100 yards endwise of any other trap or fixed fishing appliance."

The position taken by defendant is unique, but it is not tenable. Congress has said that the waters of any creek, stream, river, estuary, or lagoon shall not be fished with a fixed fishing appliance for more than one-third of the distance across or above the tide waters of such creek, stream, river, estuary, or lagoon; that a trap or fixed fishing appliance shall not be driven or constructed within 600 yards laterally or within 100 yards endwise of any other trap or fixed fishing appliance. It is argued that no right to continue to drive or construct is initiated by beginning to drive or construct. It is true that the statute specifies no period of time within which the trap or fixed fishing appliance must be completed, but the failure to so specify can not be held to mean that no time shall be given. The very nature of the language employed, "to drive or construct," as applied to the thing to be driven or constructed does not contemplate a completed structure by a single act. Construct means to put together the constituent parts of (something) in their proper place and order; to build; to form; to make, as to construct an edifice; and the spirit and intent of the statute is fully complied with when a trap or fixed fishing appliance once begun and under process of construction is being driven and constructed with such speed as existing conditions reasonably permit. To have fixed a definite period of time irrespective of weather conditions and unavoidable delays would have been equally as objectionable. I take it Congress was not attempting to place a bonus upon specially adapted equip-

ment and speed in trap construction. No time is fixed for beginning work, nor when it must be finished. In this case it probably would not make much difference, for the defendant and the Packers are both undoubtedly able to enter a race on "trap" construction on equal terms, but if it is determined that the statute looks forward to, in fact invites, a race in trap construction, it is easy to be seen that an independent fisherman will never be able to construct a trap if formidable competition seeks to render his efforts useless.

Time, however, is not the only yardstick by which the rights of the trap builder are to be measured. Under the provisions of the statute the length of a trap or fixed fishing appliance must not be greater than one-third of the width of the creek, stream, river, estuary, or lagoon across which it is driven or constructed, and when the builder of a trap begins his trap at a point offshore and at a distance therefrom less than one-third of the width of the stream or estuary across which he is driving or constructing his trap, it must be held that within a reasonable limit of time he alone has the right to determine how far he will continue to drive and construct his lead toward the shore. I find the defendant guilty as charged in the complaint.

The Canoe Pass Packing Co. and the Northwestern Fisheries Co., jointly indicted at Valdez in October, 1918, were tried before the district court at that place in October, 1919. These companies were accused by the grand jury of unlawful fishing in Miles Lake by the use of set nets at less than the distance interval prescribed by the regulations affecting fishing in the Copper River, the indictment covering four counts against each company. The trial began October 20, and two days later the jury returned a verdict of guilty on all counts of the indictment. Motion for a new trial being made and denied on October 24, the court imposed a fine of $1,000 against each company, or $250 for each count. The costs of the trial, amounting to $307.30, were paid by the two companies.

The Abercrombie Packing Co., similarly indicted in 1918, was put on trial October 23. It was alleged in the indictment that the nets of this company were set within the prohibited lateral distance of those nets of the Northwestern Fisheries Co. and the Canoe Pass Packing Co., which were proved by the preceding trial to have been unlawfully placed. It therefore followed that the conviction of those companies virtually amounted to an acquittal of the Abercrombie Packing Co., which, from all the evidence presented, was the first to set its nets at the three points in question. Accordingly the court instructed the jury to return a verdict of not guilty on three counts of the indictment, whereupon the remaining count was dismissed upon motion of the United States attorney, as the evidence was insufficient to convict.

On Sunday, June 15, a trap of the Moore Packing Co., at Knowles Head, Prince William Sound, was found in full fishing order, and on the following day complaint was filed before the United States commissioner at Valdez against the company and the trap watchman. When the matter came to trial the company pleaded guilty solely on the ground that it was responsible for the acts of its employees. In this case the watchman was uncertain about the day of the week, having once closed the trap and then reopened it. A fine of $100, and costs amounting to $46.30, was imposed against the company. The case against the watchman was dismissed.

On July 10, John Roach, Harry Hendrickson, E. Carlson, and W. T. Wiseman, all fishermen of the Alaska Salmon Co., were caught fishing in Wood River, a stream closed to commercial fishing. They were arrested and brought before the United States commissioner at Dillingham on July 30 for trial. Roach and Carlson, fishermen from San Francisco, pleaded guilty, and a fine of $250 and costs of $20

was imposed against each. Hendrickson, a local fisherman, also pleaded guilty and was fined $100. Wiseman, a prospector in Alaska who sometimes earned a grubstake by fishing, demanded a trial by jury. The case against him was dropped, as it would have been difficult to have found 12 men in that section who could qualify as jurors. This is the second time that any prosecutions have been made in the Bristol Bay district. The first occurred in 1914.

FISH PIRACY.

In the fishing season of 1919 southeast Alaska was the scene of an attempt by a lawless element to carry on salmon-trap piracy. Some traps were raided and robbed during the absence of the watchmen, or through their intimidation, but these depredations were mainly unsuccessful, though one company reported the loss of 60,000 salmon from this cause. The situation was sufficiently serious to occasion the operators no little concern and also to engage the active attention of the law-enforcement agencies in the Territory. Vessels of the Navy, Coast and Geodetic Survey, Forest Service, and Bureau of Fisheries were authorized by the several departments represented to take summary action in dealing with the evil. The governor of Alaska and the Department of Justice, through the United States marshal and his deputies, took a large part in the suppression and punishment of this lawlessness. Some prosecutions were made and convictions secured, but piracy was brought to an end chiefly by an organized patrol under Federal and Territorial authorization and the cooperation of several packing companies.

It would seem that the companies operating traps might evolve a plan of self-protection to prevent a recurrence of this disorder, for the theory is fundamentally correct that if the salmon obtained through piracy can not be sold or disposed of at a profit, the raiding and robbing of traps will cease.

TERRITORIAL LEGISLATION.

By an act approved May 1, 1919, the Legislature of the Territory of Alaska amended sections 1 and 2 of the Territorial revenue act of May 3, 1917, chapter 74, Laws of Alaska, 1917. The changes include the imposition of a tax on the output of clam canneries, herring canneries, and whale-oil plants; an increase of 1 cent a case on all species of salmon canned and in addition a tax on the net income of salmon canneries; and increased rates on various salted products. The act as it applies to fisheries is as follows:

SECTION 1. That any person, firm, or corporation prosecuting, or attempting to prosecute, any of the following lines of business in the Territory of Alaska shall apply for and obtain a license, and pay for said license, for the respective lines of business, as follows:

* * * * * * *

6th: Fisheries:

(a) Clam canneries: Two cents per case;

(b) Herring canneries: Two cents per case;

(c) Salmon canneries: Five and one-half cents per case, on Kings and Reds or Sockeyes; three and one-half cents per case on Medium Reds; and three cents per case on all others.

In addition to the above tax, salmon canneries shall pay one per cent of their net annual income. By "net" income is meant cash value of the pack of the cannery, less operating expenses, and repairs and betterments actually made. No deduction

shall be made as an operating expense on account of depreciation of machinery, interest on bonds or money borrowed, or other taxes paid.

(d) Fish traps, fixed or floating: one hundred dollars per annum, so-called dummy traps included;

(e) Salteries: Ten cents per one hundred pounds on mild cured Red King Salmon;

Five cents per one hundred pounds on mild cured White King Salmon;

Ten cents per one hundred pounds on salted Codfish;

Two and one-half cents per one hundred pounds on all other salted and mild cured fish, except Herring.

7th: Cold Storage Plants: Doing a business of one hundred thousand dollars per annum or more, five hundred dollars per annum; doing a business of seventy-five thousand dollars per annum and less than one hundred thousand dollars, three hundred and seventy-five dollars per annum; doing a business of fifty thousand and less than seventy-five thousand dollars per annum, two hundred and fifty dollars per annum; doing a business of twenty-five thousand and less than fifty thousand dollars per annum, one hundred and twenty-five dollars per annum; doing a business of ten thousand dollars and less than twenty-five thousand dollars per annum, fifty dollars per annum; doing a business of four thousand and less than ten thousand dollars per annum, twenty-five dollars per annum; doing a business of under four thousand dollars per annum, ten dollars per annum.

The "annual business" under this section shall be considered the gross amount received for the product and for storage of produce for others.

8th: (a) Fish oil works using herring in whole or in part in the manufacture of fish oil, two dollars per barrel. (b) Fertilizer and fish meal plants manufacturing fertilizer and fish meal in whole or in part from herring, two dollars per ton.

* * * * * * *

17th: Whale Oil Plants or Stations: One dollar per barrel.

TERRITORIAL LICENSE TAX.

Information has been received from the Territorial treasurer of Alaska in respect to tax collections made for the fiscal year ending December 31, 1919, under the several fisheries schedules of the Territorial tax law. The following statement is of date of May 22, 1920:

FISHERY LICENSE TAXES COLLECTED BY TERRITORY FOR THE FISCAL YEAR ENDED DEC. 31, 1919.

Schedule.	Division No. 1.	Division No. 2.	Division No. 3.	Total.
Salmon canneries	$96,592.52	$2,442.03	$68,228.57	$167,263.12
Herring canneries	1,288.44		683.58	1,972.02
Clam canneries			288.56	288.56
Salteries and mild-cure plants	3,431.90	50.30	3,191.47	6,673.67
Fish traps	52,600.00		23,000.00	75,600.00
Cold-storage plants	1,525.00		510.00	2,035.00
Fish-oil works and fertilizer and fish-meal plants	2,287.55			2,287.55
Whale-oil plants	7,731.00		16,680.00	24,411.00
Total	165,456.41	2,492.33	112,582.18	280,530.92
Additional tax [a]				20,770.67
Grand total				301,301.59

[a] Additional tax of 1 per cent of their annual net incomes collected from salmon canneries (not possible to segregate by divisions).

The Territorial treasurer, in reporting collections as above, made the following comment:

Several of the smaller salmon-cannery concerns have not yet made payment of their 1919-pack taxes; however, as the amount involved is not large and as it may be some time before payment is made, it is not deemed advisable to longer delay in furnishing your department the desired data.

Referring to collections under Schedule "Clam canneries," same are not yet complete for the year, but the amount involved is only a matter of possibly $200 or there-

abouts. Fish-saltery taxes will continue to come in for some time yet, but any such taxes now delinquent are all for small sums.

In addition to amount reported in above statement under Schedule "Fish-oil works and fertilizer and fish-meal plants," the sum of $6,492 was also collected under said schedule; however, such item is not included in statement for the reason that it is being held on special deposit owing to unsettled litigation regarding the schedule in question.

TERRITORIAL FISH COMMISSION.

At the session of the legislature early in 1919 provision was made for a Territorial fish commission to consist of five members. The sum of $80,000 was appropriated for its work. The governor is chairman of the commission and the remaining four members are appointed by him for terms of two years, subject to confirmation by the Territorial Senate.

The work of the commission in 1919 was more or less preliminary in nature. A superintendent of hatchery operations was appointed and other employees secured, and fish-cultural operations were capably conducted at Juneau. This work was largely the outgrowth of operations of the Alaska Fish & Game Club, an organization made up of local sportsmen and persons interested in the conservation of the fisheries, both from the point of view of the angler and the commercial producer. Other plans of the commission include the improvement of salmon streams for spawning purposes by the removal of obstructions; allotments of funds were made for this work in the southeast, central, and western districts.

Late in the year members of the Territorial fish commission participated in a conference at Seattle to consider the advisability of framing additional legislation in respect to the fisheries of Alaska.

PREDATORY BIRDS.

From time to time it has been reported that certain birds in Alaska feed very largely on the eggs and fry of salmon and other food fishes and that their depredations are of such magnitude as to threaten seriously the supply of fish, especially salmon. Practically all birds in this category are protected by international agreement under the Migratory Bird Treaty and therefore can not be killed lawfully except by specific order. After due consideration of the facts, the Secretary of Agriculture issued an order on October 24, 1919, authorizing the killing of certain birds at fish hatcheries. The order is as follows:

ORDER PERMITTING THE KILLING OR TRAPPING OF CERTAIN BIRDS, AT FISH HATCHERIES, FOUND TO BE INJURIOUS TO VALUABLE FISH LIFE.

Information having been furnished the Secretary of Agriculture that grebes, loons, gulls, and terns, mergansers, and certain species of the heron have become, under extraordinary conditions, seriously injurious to and destructive of fishes at fish hatcheries in the United States and Alaska, and an investigation having been made to determine the nature and extent of the injury complained of, and whether the birds alleged to be doing the damage should be killed; and, if so, during what times and by what means, and it having been determined by the Secretary of Agriculture that the birds above mentioned have become, under extraordinary conditions, seriously injurious to and destructive of fishes at fish hatcheries in the United States and Alaska, and that such birds found committing the damage should be destroyed;

Now, therefore, I, D. F. Houston, Secretary of Agriculture, pursuant to authority in me vested by the Migratory Bird Treaty Act of July 3, 1918, and agreeably to Regulation 10 of the Migratory Bird Treaty Act Regulations approved and proclaimed July 31, 1918, do hereby order that the owner or superintendent, or a bona fide employee of a public or private fish hatchery in the United States or in Alaska, for the

purpose of protecting the fishes at such hatchery, may shoot or trap the following birds at any time on the grounds and waters of such hatchery:

Grebes (Colymbidæ), locally also called water-witches or hell divers.

Loons (Gaviidæ).

Gulls and terns (Laridæ), the latter commonly also called sea swallows.

Mergansers (Merginæ), commonly also called sheldrakes or fish ducks.

The following species of the heron family (Ardeidæ)—

Bittern (*Botaurus lentiginosus*), locally also called shitepoke, stake driver, thunder pump, etc.

Great blue heron (*Ardea herodias*), locally also called blue crane, Poor Joe, cranky, etc.

Little blue heron (*Florida cærulea*), locally also called scoggins.

Green heron (*Butorides virescens*), locally also called shitepoke, fly-up-the-creek, scouck, etc.

Black-crowned night heron (*Nycticorax nycticorax nævius*), also known as gros bec, quawk, qua-bird, etc.

Every bird killed or trapped pursuant to the permission contained in this order, and every part thereof, including the plumage and feathers, shall be totally destroyed as promptly as possible, and shall not be possessed, transported, or shipped in any manner outside of the grounds and waters of the hatchery where killed or trapped except for the purpose of destruction as herein directed: *Provided, however*, That such birds or parts thereof may be shipped or transported, as a gift but not for sale, to public museums and public scientific and educational institutions, and all packages containing such birds or parts thereof so shipped or transported shall be plainly and clearly marked so that the name and address of the shipper and the nature of the contents may be readily ascertained on an inspection of the outside thereof.

ALEUTIAN ISLANDS RESERVATION.

Permits for fishery operations in the Aleutian Islands Reservation, which were effective at the end of 1918, continued through the season of 1919, with the exception that permit No. 23, granted November 1, 1917, to the Kuskokwim Fishing & Transportation Co., for cod and salmon operations at Trident Bay, was canceled on May 12, 1919. The company advised that its efforts had been a failure and it had abandoned the location. Six additional permits were issued during the season of 1919, which, with the 20 granted previously which remain effective, make a total of 26 permits outstanding at the end of the calendar year 1919.

Permits for Fishery Operations in Aleutian Islands Reservation Granted During Calendar Year 1919.

No.	Date.	Grantee.	Location and scope of operations.
36	Jan. 13	O. K. Quean	Commercial fishery operations; erection of cannery prohibited.
37	Feb. 7	H. O. Wick	Tigalda Island. Cod station.
38	Mar. 25	T. R. Gawley	Dora Harbor, Unimak Island. Cod station.
39	Apr 12	Standard Fish Co	Bay of Islands, Adak Island, and Chernofski Harbor, Unalaska Island. Commercial fishery operations; erection of cannery prohibited.
40	Sept. 5	Buckley Livestock, Fisheries & Transportation Co.	Chernofski Harbor and Kuliliak Bay, Unalaska Island, Cod and salmon operations; erection of cannery prohibited.
41	Sept. 6	Lars Mikkelsen	Six locations on Unalaska Island, Akun Island, and Tigalda Island. Cod stations.

Two permits for grazing purposes within the Aleutian Islands Reservation were granted jointly by the Departments of Agriculture and Commerce in 1919. The permit granted to Andrew C. Smith on July 5, 1917, for grazing on Umnak Island was canceled, and a similar permit issued to the Buckley Livestock, Fisheries & Transportation Co., which company has taken over his interests in the

reservation. The two permits previously granted the Buckley Livestock, Fisheries & Transportation Co. and Emil Ittner for grazing on Unalaska Island and Amaknak (Dutch Harbor) Island, respectively, remained effective in 1919.

JOINT PERMITS IN ALEUTIAN ISLANDS RESERVATION GRANTED IN CALENDAR YEAR 1919.

Date.	Grantee.	Purpose and location.
Mar. 8	H. O. Wick	To graze stock and sheep on Tigalda Island.
Oct. 13	Buckley Livestock, Fisheries & Transportation Co.	To graze live stock on Umnak Island.

AFOGNAK RESERVATION.

The Afognak Fishery Reservation was established in 1892 by proclamation of President Harrison. All commercial fishing in the Territorial waters of Afognak Island was terminated, and the two salmon canneries in operation on Litnik Bay were closed and finally removed from the island. During the next 20 years unauthorized commercial fishing was carried on by resident whites and natives, who sold their catches to merchants at Afognak and Kodiak. Every locality about the island which produced an appreciable run of salmon was fished. The catch was used chiefly in the preparation of pickled bellies and dried and smoked backs.

Early in 1912 information was laid before the Department to the effect that the natives of Afognak were largely dependent upon the salmon fisheries of the island for a livelihood. To properly conserve the fisheries and to assist the natives, an order was issued by the Department whereby the natives and white men married to native women were permitted to fish in the reservation for commercial purposes after first obtaining a license. Accordingly, in the spring of 1912, more than 100 licenses were issued to these people, and in each season since then the same privilege has been granted. Necessary restrictions have been imposed in order that the salmon runs may be protected from close fishing, which might otherwise ensue. These restrictions applied to the kind and amount of gear which could be used and to the seasons when operations might be carried on. Each locality was given special consideration by the establishment of close seasons during the summer, for which the general law made no provision, the object being to insure some escapement of salmon to the spawning grounds.

The conduct of the work thus begun in 1912 has been continued without much change to the present writing. The runs of salmon have varied somewhat in the eight seasons which have passed, yet there appears to be no striking difference in the situation to-day from that in 1911. The fisheries have survived the disaster of 1912, when the eruption of Mount Katmai filled all streams of the island with volcanic ash, and salmon are now about as plentiful as before that catastrophe. Taking the streams separately, it is observed that those on the west side of the island are not producing as many red salmon as they did before the eruption, but the island as a whole shows a rather uniform production if some allowance is made for the lean

years immediately following 1912. The present condition is neither particularly encouraging nor discouraging.

The streams on the east side of the island show a general improvement in the runs of salmon as compared with several years ago, and it seems probable that they will continue to improve under the increased liberation of fry from the hatchery on Litnik Lake. It is of special interest to record in this connection that red salmon appeared in greater numbers in 1919 than ever before in Litnik Bay, and that the collection of red salmon eggs at the hatchery was the largest ever made. In round numbers 78,000,000 eggs were taken, and it was estimated that there remained on hand a supply of unspawned salmon sufficient to have refilled the hatchery with eggs had opportunity been available.

The commercial catch of salmon in Afognak waters is shown in the following table:

Catch of Salmon by Apparatus and Species, Afognak Reservation, 1919.

Locality.	By seines.					By gill nets.	Total.
	Coho.	Chum.	Humpback.	King.	Red.	Red.	
Little Afognak	5,179	119	2,112	....	19,830	3,505	30,745
Litnik Bay	5,203	....	....	....	....	....	5,203
Paramanof Bay	35	235	12,344	....	14,854	3,714	31,182
Malina	....	248	1,098	22	18,430	4,607	24,405
Danger Bay	....	....	5,871	....	27	....	5,898
Seal Bay	....	....	1,573	27	11,634	....	13,234
Izhut Bay	....	....	....	....	754	1,219	1,973
Pauls Bay	....	....	....	....	523	....	523
Total	10,417	602	22,998	49	66,052	13,045	113,163

The customary patrol of the fishing grounds in the Afognak Reservation was again followed in 1919, William E. Baumann, of Afognak, being employed temporarily to carry on the work, which, as heretofore, included general supervision of all commercial fishing in the reserved waters.

Litnik Bay was not open to commercial fishing except for silver salmon; this accounts for the fact that but the one species was taken there. All the red salmon were wanted for purposes of propagation, while the run of humpbacks was inconsequential.

In comparison with the catch of 1918, it appears that cohos increased 102 per cent; humpbacks decreased from 70,791 to 22,998, a decline of 67½ per cent; and reds increased from 50.662 to 79,097, an advance of 56 per cent. Chums and kings were taken in negligible quantities. The entire catch was sold to the Kadiak Fisheries Co., at Kodiak.

Approximately 90 per cent of the catch was made by means of beach seines, the remainder being taken with gill nets. The streams are small and clear, hence gill-net fishing is not practicable off their mouths. Traps are not permitted, and purse seines are not used for the reason that the natives are not prepared to operate them.

ANNETTE ISLAND FISHERY RESERVE.

The Annette Island Fishery Reserve, in southeastern Alaska, was created by a Presidential proclamation dated April 28, 1916, for the benefit of the Metlakatla Indians and any other natives of Alaska who might care to take up their abode on Annette Island. The reserve includes Annette Island and a number of smaller adjacent islands, together with the surrounding waters, and is administered by the Bureau of Education, Department of the Interior, in the interests of the resident natives.

The season of 1919 was the second in which fishery operations within the reserve were carried on in accordance with the five-year contract entered into with the Annette Island Packing Co. By the terms of this contract the contracting company pays a fee of $100 a year for each fish trap operated and a royalty of 1 cent for each fish taken from these traps. In addition the company pays the natives for fish taken in seines. The natives also receive payments for other services and materials furnished by them. In 1919 the fees from the seven fish traps operated amounted to $700; 794,625 fish were taken from the traps, providing a royalty of $7,946.25; and the amount paid the natives for fish taken by purse seines amounted to $25,231.85. The total income to the natives, including the Metlakatla Commercial Co., from the Annette Island Packing Co. for the season of 1919 was $90,032.88.

COPPER RIVER FISHERY.

At the close of the fishing season of 1918, it was found that the regulations of December 29, 1917, affecting fishing for salmon in the Copper River had failed to accomplish the purposes sought by their promulgation, namely, an escapement of salmon sufficient to provide for the ample seeding of the spawning beds and to supply the needs of the natives and other inhabitants of the region. Furthermore, it was repeatedly alleged that the regulations were discriminative in effect for the reason that operations in the delta district were materially restricted while those at Abercrombie Canyon and Miles Lake were almost unaffected. It was expedient, therefore, that appropriate action be taken looking toward a revision of the regulations in order that the original objects in view should be attained.

On September 16, 1918, announcement was made of a hearing to be held at Seattle, Wash., November 22, 1918, to consider the matter of changing the existing Copper River regulations. As a result new regulations were promulgated on December 20, 1918, effective January 1, 1919. The important changes in the new order were the extension of the weekly close season by 10 days in all parts of the river, the omission of the weekly close period of 36 hours, the prohibition of all stake nets, a reduction of 1,200 feet in the lateral distance interval and of 200 feet in the length of all nets the use of which was authorized in the waters of the delta over which the Secretary of Commerce has jurisdiction, an extension of 200 feet in the length of all nets whose use is permitted in Miles Lake, the closing of the west and north shores of Miles Lake and the east side of the river through Abercrombie Canyon, and a redefining of the delta

by the exclusion of all areas not strictly in the river or its outlets or within 500 yards outside the mouth of each.

Under the new definition of the Copper River delta, fishing on the tide flats between the grass banks and the sand islands 3 or 4 miles offshore was unaffected, except as the prohibitions of the general law were applicable. By reason of that fact, the packing companies having canneries at Cordova and near the delta put their fishing gear in operation in this open field as soon as salmon began to run, and they made a very considerable catch before fishing could be commenced in the protected waters. Even after the close season had elapsed and all waters of the delta were open to commercial fishing, the flats were the preferred grounds and the bulk of the catch was made there. When the season was at its height there were approximately 65,000 fathoms of gill nets in operation on the delta. The greater part of this gear was used in the form of stake nets, though a small quantity was used as set nets in the sloughs, leaving the remainder for drift fishing in the channels crossing the tide flats.

Fishing in the delta district began about the middle of May and was diligently prosecuted until early in July, about which time all of the companies except the two nearest the field withdrew their men for the humpback fishing in Prince William Sound. The excepted companies did not stop fishing on the delta until late in August. The total catch of salmon in the waters of the delta was 1,129,934. Of this number 1,096,090 were red salmon; 8,972, kings; and 24,872, cohos.

In Miles Lake, all fishing was by means of gill nets, a total of 3,250 fathoms being used. Fishing in the canyon was carried on by the use of dip nets, there being from 20 to 50 men employed as dip-net fishermen, the number varying with the fluctuations in the run of salmon. Fishing began both in lake and canyon on June 15 and continued until September 16. The following catch of salmon was made: Reds, 157,597; kings, 4,092; and cohos, 15,778; or a total of all species of 177,467. This entire catch was canned by F. H. Madden at the Abercrombie cannery, formerly operated by the Abercrombie Packing Co. The following number of cases of salmon was packed: Reds, 13,933 cases of 1-pound talls and 1,248 cases of ½-pound flats; kings, 1,383 cases; and cohos, 1,461 cases.

The total catch of salmon in Copper River waters was 1,307,401, of which number 1,253,687 were reds, 13,064, kings, and 40,650 cohos.

Early in the season Assistant Agent E. M. Ball of the Bureau's staff and Special Agent Joseph A. Bourke, whose services had been temporarily secured by detail through courtesy of Gov. Riggs, erected a number of notices on the Copper River delta, indicating the extent of the waters affected by departmental regulations. Soon thereafter Mr. Ball returned to Cordova and devoted his attention to fishery matters in the Prince William Sound region and to the westward. Mr. Bourke continued to act for the Bureau during the fishing season on the Copper River. Newt Casperson was employed in special capacity and stationed for a number of weeks in the vicinity of Miles Lake and Abercrombie Canyon.

The great importance of the Copper River fishery and the several unusual problems involved in connection therewith, especially in regard to the extent of the spawning areas, seemed to demand a special inquiry into conditions in order that as complete information

as possible might be available for future guidance. Accordingly arrangements were made for an investigation under the leadership of Dr. Henry B. Ward, of the University of Illinois. Associated with Dr. Ward were Prof. W. A. Oldfather, also of the University of Illinois, and J. R. Russell, superintendent of the Bureau's fish-cultural stations in Washington. The party arrived at Cordova on July 17, 1919, and proceeded up the Copper River & Northwestern Railway, thence taking a local guide and suitable camping equipment. The investigation covered several hundred miles of territory and included visits to a number of the more important spawning grounds on the tributary streams and lakes of the Copper River system. The party returned to Cordova September 6, 1919. A complete report submitted by Dr. Ward is given on page 119.

YUKON RIVER FISHERY.

In 1919 the Yukon River salmon fisheries assumed a position of large interest due to the successful operation of a cannery on Kwiguk Pass or Slough near the upper end of Kwikluak Pass, the most southerly outlet of the Yukon. The commercial utilization of salmon dates back to 1918 only, as prior to that year all salmon taken from the Yukon were used locally. The canning of Yukon salmon was begun in 1918 by the Carlisle Packing Co., rather as development or experimental work. The company was entering virgin territory, where business prudence required that it make a practical test of the feasibility of commercial operations in a region whose fishery wealth was almost unknown. Operations were conceded to be of experimental nature to determine whether the size of the runs of salmon would warrant the permanent establishment of a cannery on the river. Until that time little was known regarding the number of salmon ascending the Yukon River and its tributaries, though it was generally understood that a considerable catch was made annually by the natives for domestic use. The number thus taken probably did not exceed a few hundred thousand salmon each season, or a comparatively small number for a river of such size. The canning company made a total catch in 1918 of 115,531 salmon, more than half of which were chums.

In 1918 strong objections were made in certain quarters to cannery operations on the Yukon. Toward the end of the season, these objections took form and culminated in protests by some of the natives and white settlers along the river against the continued operation of this cannery, or the establishment of any more, the basic contention being that the supply of salmon was not more than adequate for local requirements. In contradiction of these representations, the packing company insisted that the runs were of enormous proportions and that fishing as conducted in the lower reaches of the river had made no appreciable impression on the supply of salmon and that in all probability it never could.

In November, 1918, a public hearing was held at Seattle, Wash., to determine the need, if any, of limits upon commercial fishing in the Yukon River as a means of safeguarding the fishery, and to ascertain the facts in regard to conflicting opinions and expressions bearing upon the entire matter. The information presented at the hearing showed the existence of a situation which might become serious if

reasonable protective regulations were not made effective. Bishop P. T. Rowe, in charge of Episcopal Church affairs in Alaska, expressed the opinion that it was not so much that one cannery might result disastrously, but that it might be the thin entering wedge of extensive commercial exploitation. At the same time W. T. Lopp, chief of the Alaska division of the Bureau of Education, entertained a similar view. He felt that some regulation was necessary, but that reasonable cannery operations could be permitted with safety.

The outcome of the hearing was the promulgation of regulations which included prohibiting the taking of salmon for export purposes from the Yukon and its tributaries above the junction of Clear River and the Yukon, and limiting the case pack and the number of barrels and tierces which might be pickled or mild cured. The pack of canned salmon was limited to 30,000 cases; pickled salmon, to 1,000 barrels; and mild-cured salmon, to 200 tierces.

In 1919 the total number of salmon taken from Yukon River waters for export was 469,949, divided as follows: Cohos, 37,070; chums, 327,898; kings, 104,822; and reds, 159. The pack was as follows: Cases, 57,085; barrels, 214; tierces, 47. Of the total number of salmon caught, it was reported that 29,256 cohos, 194,452 chums, 65,433 kings, and 159 reds, an aggregate of 289,300 were taken in waters outside the scope of the regulations referred to above. The catch within the river was 180,649 salmon. Thus it appears that approximately 62 per cent of the commercial catch of salmon in Yukon River waters was taken in areas beyond the jurisdiction of the Department of Commerce, while only 38 per cent were caught within such areas.

In addition to the cannery of the Carlisle Packing Co., there were four salteries operated on the lower Yukon River in 1919. The Delta Fish Co. was located about 2 miles above the entrance to Kwiguk Slough; J. J. Stokes, about 4 miles below Aproka Pass; William O'Connor, 4 miles above the entrance to Akularak Slough; and the Fuller Fish Co., at the mouth of Andreafski River. Operations of all these concerns were upon a small scale, the total pack being only 239 barrels of pickled salmon. The Delta Fish Co. was the only one that salted in tanks and afterwards transferred their pack to barrels for shipment. The pack of J. J. Stokes was disposed of locally, as was also the pack of William O'Connor. The Fuller Fish Co. intends to operate on a larger scale next year. Part of their pack this season was sent to the States and the balance sold locally. John Lamont has an outfit of barrels, salt, and fishing gear ready to begin operations another season.

During the fall and winter of 1919 concerted action of ecclesiastical inception was undertaken to end commercial fishing for salmon in Yukon River waters, it being alleged that a continuance of such activities meant the destruction of the salmon runs, without which the natives would be unable to survive as a self-supporting people. Undoubtedly the salmon of the Yukon are indispensable to the ordinary development of the country and economical maintenance of human life therein. Various industries of interior Alaska, such as mining and trapping, are more or less directly or indirectly dependent upon salmon. Fishing is not carried on by the resident whites to an extent that would constitute an industry. The natives, however, spend part of their summers in catching salmon and drying them for winter food for themselves and their dogs. Some of them prepare annually quan-

FIG. 1.—NATIVE SALMON FISHERY, YUKON RIVER.

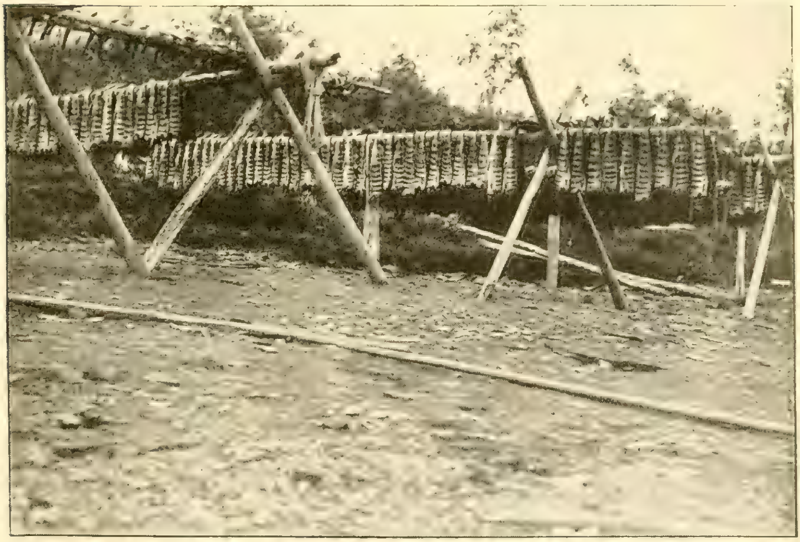


FIG. 2.—NATIVE METHOD OF CURING SALMON, YUKON RIVER.

tities of fish over and above their own needs and sell them to trappers, prospectors, military telegraph stations, and commercial companies at various places along the river.

In the propaganda circulated by Archdeacon Hudson Stuck late in 1919 it was asserted that the cannery near the mouth of the Yukon was operated under permission granted by the Bureau of Fisheries. No such permission was granted, nor was any asked; in fact the Department of Commerce has authority only to limit fishing operations but not to prohibit the establishment of canneries. Allegations were made at the same time as to the great privation caused to the natives and other residents of the Yukon and tributary waters because of the shortage of the salmon in 1919. Undoubtedly there was a light run of salmon in 1919 in the Yukon, as there was in practically all other waters of Alaska; it was an unfavorable season for salmon throughout Alaska. The light run in the Yukon has had its counterpart heretofore, as it is a matter of record that in earlier years the runs of salmon have been very light. There is authentic record of limited runs of salmon as far back as 1879, in which year the natives of the Yukon were forced to go to Norton Sound and elsewhere for salmon.

It seems appropriate to point out that in 1919 there was much high water in the Yukon, which interfered with the operation of native fishing gear; heavy quantities of driftwood also lessened the take of salmon by the natives. Over and above all, consideration must undoubtedly be given to the psychological effect of the establishment of the cannery on the natives; they heard that the cannery was in operation, hence at once assumed that there would be no salmon passing to upper waters. They, therefore, in many instances did not make proper effort to take salmon.

An extensive investigation of the Yukon was made by Inspector Townsend, of the Alaska service, who covered more than 4,000 miles of Yukon waters on the Bureau's vessel *Swan*. He interviewed many traders and other residents of the Yukon in order to ascertain the actual condition of the natives. In some instances it was found that the natives not only had enough fish for themselves, but were able to make sales of the surplus; elsewhere shortages were recorded. But as the season progressed there was no information from official sources received by the Bureau or by the governor of Alaska, which indicated that there had been undue privation suffered during the year by the natives because of any shortage of salmon.

In 1918 it was reported that 6,638 whites, 4,269 natives, and 6,183 dogs were dependent largely upon the salmon of the Yukon. It is computed that about 1,100,000 salmon would suffice amply for all such food requirements. Present requirements are materially smaller, as influenza has since taken heavy toll of the Yukon natives. It must not be overlooked that there are various other species of fish in the Yukon, such as whitefish, grayling, and trout, available for food purposes. The whitefish is a close relative of the famous whitefish of the Great Lakes. The natives also have an abundant supply of game to augment their larder.

It is not the province of the Department of Commerce in its legal relation to the fisheries of Alaska to consider as paramount the interests of any particular packing company or of any branch of the fishery industry, or any class of people, but under the law it is charged primarily with the protection of the salmon fisheries. Congress has

given the Secretary of Commerce authority to do certain things when in his judgment the protection and preservation of the fisheries demand such action. The Department will therefore give unbiased consideration to all the information which comes before it touching upon the questions involved, but it is not required to accept as correct anything less than a fair, unprejudiced presentation of the facts.

The two main contradictory views involving the Yukon situation are, first, that of the commercial interests which contend that there are large runs of salmon in the Yukon and that the number taken for their purposes is but a small fraction of the total; and second, that of certain of the natives and others who maintain that the runs are small and that no salmon can be exported without a resulting local state of privation. The question of large interest, however, to the Department is not whether commercial fishing shall cease in order that noncommercial fishing may continue, but whether the runs of salmon in the Yukon are being or will be depleted under the present scale of operations. It is proper that cognizance be taken of any condition that threatens to destroy the fisheries, whether it be the result of operations by a packing company or by a resident population, or by both.

There is much to be learned regarding the salmon runs in the Yukon before the Department considers further limitations upon fishing in those waters. Competent investigators will, therefore, be sent to the Yukon in 1920 to study the salmon runs and to ascertain the actual conditions of the natives in their relation to the salmon fisheries. Further regulations of the Yukon salmon fisheries will depend very largely upon the results of their observations. It remains true that a just regard for the rights of humanity must inevitably weigh heavily in considering the final regulation of these fisheries, but it seems now that the Yukon can support at least a reasonable commercial fishery for salmon and at the same time insure an ample supply for local food purposes in perpetuity.

CENTRAL AND WESTERN ALASKA FISHERY.

In order that the Bureau might be in possession of accurate and trustworthy information regarding certain phases of the salmon fisheries of central and western Alaska, arrangements were made for a joint investigation by Dr. C. H. Gilbert, of Stanford University, engaged as special assistant, and Henry O'Malley, field assistant. Dr. Gilbert and Mr. O'Malley left Seattle on May 12 and returned early in September, 1919. While en route to western Alaska, a stop was made at Cordova, from which place local trips were made in connection with Copper River fishery conditions. Thereafter the journey to the Bristol Bay region was continued, the overland route from Iliamna being followed. A number of weeks were spent on Bristol Bay waters and tributaries, following which inquiries were made in the Port Moller and Ikatan regions. The conclusion of major field work was in the vicinity of Karluk. Much valuable information was secured as a result of the investigation. The report of Dr. Gilbert and Mr. O'Malley is given on page 143.

WOOD RIVER CENSUS.

A count of the salmon entering Lake Aleknagik, on Wood River, in western Alaska, was made in 1919 in accordance with the custom of past seasons. Warden Shirley A. Baker had general supervision of the work. The actual count was intrusted to Russell Noyes, fish-culturist at Afognak station, who was assigned to this special duty. He was assisted in the counting by three men in the employ of the Alaska Packers Association.

The rack, consisting of heavy cotton web attached to piling driven across the lower end of the lake just above the outlet, was made ready by June 24. It was installed by the Alaska Packers Association, some assistance in towing equipment to the lake and returning it to the cannery at Nushagak at the completion of the count being rendered by the Alaska-Portland Packers Association.

Salmon made their appearance at about the usual time and continued to run through July, as is ordinarily the case. Counting began June 25 and stopped July 31. Weather conditions in 1919 were normal, and no circumstances arose to differentiate the season from preceding ones except the heavy decline in the run of salmon. The largest counts were made on July 10 and 11, when 31,035 and 41,519 salmon entered the lake on those respective dates. Records of the enumeration are surprising in that only 3 days out of 37 show a count in excess of 10,000 salmon. As compared with 943,202 red salmon counted in 1918, the census gives a total of 145,114 red salmon as having entered Lake Aleknagik in 1919. Details of the count appear in the following table:

Wood River Salmon Census in 1919.

Date.	Number.	Date.	Number.	Date.	Number.
June 25	62	July 8	177	July 21	513
26	91	9	3,480	22	437
27	5	10	31,035	23	827
28	208	11	41,519	24	513
29	203	12	7,610	25	327
30	219	13	2,116	26	172
July 1	379	14	1,530	27	252
2	799	15	6,734	28	59
3	830	16	4,795	29	128
4	5,111	17	1,988	30	179
5	23,108	18	925	31	156
6	6,831	19	336		
7	1,055	20	405	Total	145,114

Upon the recommendation of Dr. C. H. Gilbert, of Stanford University, who, with Field Assistant Henry O'Malley of the Bureau, made extensive investigations for the Government in Alaska in 1919, it has been decided to discontinue the Wood River census. As soon as funds are available it is planned, as recommended by Dr. Gilbert, to undertake similar work at Chignik Lake and probably also at Karluk.

In view of the discontinuance of the Wood River census, it seems advisable to present herewith the following tabulation pertaining to the work from the time of its inception in 1908 through 1919:

Wood River Census and Red Salmon Run in Nushagak Bay and Tributaries, 1908–1919.

Year.	Nushagak Bay catch.	Wood River tally.	Total.	Per cent of escape.
1908	6,140,031	2,603,655	8,740,686	30.0
1909	4,687,635	893,244	5,580,879	16.0
1910	4,384,755	670,104	5,054,859	13.2
1911	2,813,637	354,299	3,167,936	11.1
1912	3,866,950	325,264	4,192,214	7.7
1913	5,236,008	753,109	5,989,117	12.5
1914	6,174,097	(a)		
1915	5,676,457	259,341	5,935,798	4.3
1916	3,592,574	551,959	4,144,533	13.3
1917	5,679,818	1,081,508	6,761,326	15.9
1918	6,078,965	943,202	7,022,167	13.4
1919	1,452,931	145,114	1,598,045	9.0

[a] Count not made.

SALMON HATCHERIES.

EXTENT OF OPERATIONS.

Four salmon hatcheries were operated in Alaska in 1919, two by the Government and two by packing companies, and in addition some fish-cultural work was carried on by the Territory. The four hatcheries referred to have a combined hatching capacity of 280,000,000 red-salmon eggs. The Territorial work was somewhat experimental in nature.

The total collection of red-salmon eggs in Alaska in 1918 was 142,001,000, from which there were hatched and liberated in the waters of Alaska 95,969,700 fry, or 5,579,500 more than in 1917–18. In 1919 the take of red-salmon eggs was 119,060,000, or 22,941,000 less than in 1918. This decrease was due to smaller runs of salmon at all the hatcheries except that of Afognak.

Operations of Alaska Hatcheries in 1919.

Station.	Red or sockeye salmon eggs taken in 1918.	Red or sockeye salmon liberated in 1918–19.	Red or sockeye salmon eggs taken in 1919.
McDonald Lake	[a]47,300,000	35,329,700	9,752,000
Afognak	[b]54,681,000	25,583,000	79,178,000
Fortmann	19,620,000	15,205,000	18,420,000
Quadra	20,400,000	19,852,000	11,710,000
Total	142,001,000	95,969,700	119,060,000

[a] 3,440,100 eyed eggs transferred to the State hatchery at Bonneville, Oreg., and 1,059,900 to Federal hatcheries in Oregon.
[b] 20,700,000 eyed eggs transferred to British Columbia, and 5,000,000 to Quinault, Wash.

HATCHERY REBATES.

The act of June 26, 1906, provides, among other things, that the catch and pack of salmon by the owners of private hatcheries in Alaska shall be exempt from all license fees and taxation of every

nature at the rate of 10 cases of canned salmon for every 1,000 red or king-salmon fry liberated upon certain conditions, which are (1) the approval of the character of their hatchery operations by the Secretary of Commerce, notice thereof to be filed in the office of the clerk or deputy clerk of the United States district court of the division of Alaska wherein such hatchery is located and the owners accordingly so notified; and (2) the filing of proof by the hatchery operators with the clerk of the court of the number of salmon fry liberated during the fiscal year for which report is made. Duplicates of such statements must also be filed with the Secretary of Commerce. The clerk of the court then issues to the owner whose hatchery operations have been approved nontransferable certificates in such denominations as he desires covering in the aggregate the number of fry so liberated. These certificates are accepted by the Government in lieu of money in payment of all license fees or taxes against the pack of canned salmon as above stated. The following table gives the rebates due to private operators for the fiscal year ending June 30, 1919.

REBATES CREDITED TO PRIVATE SALMON HATCHERIES DURING FISCAL YEAR ENDED JUNE 30, 1919.

Owner.	Location.	Red-salmon fry liberated.	Rebate due.
Alaska Packers Association	Naha Stream	15,205,000	$6,082.00
Northwestern Fisheries Co	Hugh Smith (Quadra) Lake.	19,852,000	7,940.80
Total		35,057,000	14,022.80

HATCHERY OPERATIONS.

M'DONALD LAKE.

Out of the collection of 47,300,000 red-salmon eggs taken at the McDonald Lake hatchery in 1918, a shipment of 3,440,100 eyed eggs was made to the State hatchery at Bonneville, Oreg.; one of 1,059,900 eyed eggs, to Bureau stations in Oregon; and 35,329,700 fry were liberated in waters tributary to Yes Bay, Alaska. The loss of eggs and fry aggregated 7,470,300, or approximately 16 per cent.

The collection of red-salmon eggs at the McDonald Lake station in the fall of 1919 was the smallest that has ever been made, only 9,752,000 being obtained. Operations were interrupted in the midst of the season by high water which damaged the retaining racks and permitted the escape of a large number of spawners. No humpback-salmon eggs were collected.

AFOGNAK.

The Afognak station experienced the most successful season in the history of its operations, the total take in 1919 being 79,178,000 red-salmon eggs. It was also reported that there were many salmon available for spawning still in the lake when the capacity of the hatchery had been reached. No effort was made to obtain humpback-salmon eggs.

From the collection of 54,681,000 red-salmon eggs taken in 1918, a consignment of 20,700,000 was shipped to the Fisheries Department of British Columbia for the restocking of the Fraser River, and a ship-

ment of 5,000,000 was made to the Bureau's station at Quinault, Wash. Plants of fry and fingerlings in Litnik Lake aggregated 25,583,000. The loss of eggs and fry was 3,398,000, or 6.2 per cent.

FORTMANN.

The Fortmann salmon hatchery of the Alaska Packers Association is located at Heckman Lake on Revillagigedo Island, southeast Alaska.

In 1918, a collection of 19,620,000 red-salmon eggs was made, from which were hatched and liberated through nursery ponds into the Naha Stream system 15,205,000 fry. The loss of eggs and fry was 4,415,000, or 22½ per cent. Between September 8 and November 22, 1919, a total of 18,420,000 red-salmon eggs was taken.

The collection of humpback-salmon eggs in 1918 was 3,660,000, from which there were produced and planted 3,235,000 fry, the loss of eggs and fry being 425,000, or 11.6 per cent. The number of humpback-salmon eggs taken in 1919 was 600,000, a decrease of 83.6 per cent from the previous year.

QUADRA.

The Northwestern Fisheries Co. continued the operation of its Quadra hatchery, located on Hugh Smith Lake, previously known as Quadra Lake. Spawn taking in 1918 began August 8 and was discontinued September 24. It resulted in a collection of 20,400,000 red-salmon eggs from which there were hatched and planted 19,852,000 fry. The loss of eggs and fry was 548,000, or approximately 2.7 per cent.

In 1919, the collection of red-salmon eggs at Quadra began August 12 and ended November 14; the total take was 11,710,000.

GENERAL STATISTICS OF THE FISHERIES IN 1919.

The total investment in the Alaska fisheries in 1919 was $74,181,560, an increase of $430,771 over 1918. Of this amount approximately 92 per cent was invested in the salmon industry. The fishery industry gave employment to 28,534 persons, a decrease of 2,679 from the number employed in 1918. The total value of the products in 1919 was $50,282,067, a decrease of $8,872,792 from 1918, or approximately 15 per cent. This lessened production was due almost wholly to the heavy falling off in the pack of salmon.

SUMMARY OF INVESTMENTS, PERSONS ENGAGED, AND PRODUCTS OF ALASKA FISHERIES IN 1919.

Item.	Southeast Alaska.		Central Alaska.		Western Alaska.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.
INVESTMENTS.								
Salmon canning		$33,741,891		$12,897,947		$19,855,333		$66,495,171
Salmon mild-curing		741,635						741,635
Salmon pickling				236,261		354,161		590,422
Salmon, fresh		104,336						104,336
Salmon dry-salting						103,862		103,862
Halibut fishery		1,979,457						1,979,457
Herring fishery		418,571		431,338		50,663		900,572
Cod fishery				938,699		347,376		1,286,075
Whale fishery		545,256				1,245,611		1,790,867

Summary of Investments, Persons Engaged, and Products of Alaska Fisheries in 1919—Continued.

Item.	Southeast Alaska.		Central Alaska.		Western Alaska.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.
INVESTMENTS—contd.								
Clam fishery				$147,167				$147,167
Crab fishery		$200						200
Shrimp fishery		41,796						41,796
Total		37,573,142		14,651,412		$21,957,006		74,181,560
PERSONS ENGAGED.								
Whites	7,027		3,435		5,864		16,326	
Natives	2,584		843		448		3,875	
Chinese	1,366		536		868		2,770	
Japanese	982		266		259		1,507	
Filipinos	919		280		379		1,578	
Mexicans	232		250		1,409		1,891	
Miscellaneous	246		59		282		587	
Total	13,356		5,069		9,509		28,534	
PRODUCTS.								
Salmon:								
Canned							a 4,583,688	43,265,349
Mild-cured							b 4,290,600	916,800
Pickled							b 1,622,000	195,447
Frozen							b 1,552,480	130,355
Fresh							b 5,208,327	356,688
Dry-salted							b 212,244	17,601
Dried and smoked							b 415,000	43,000
By-products, oil							c 966	966
By-products, fertilizer							b 724,000	18,680
Halibut:								
Fresh							b 7,783,179	880,433
Frozen							b 6,495,372	670,147
Canned							b 240	25
Herring:								
Canned (½-pound cans)							a 6,357	40,395
Canned (1-pound cans)							a 95,448	811,366
Dry-salted for food							b 510,000	20,150
Fresh, for bait							b 1,254,926	11,210
Frozen for bait							b 2,444,655	24,246
Pickled, for bait							b 40,000	800
Pickled, Scotch cure							b 7,718,985	451,240
Pickled, spiced							b 11,715	1,676
Pickled, Norwegian cure							b 2,216,120	147,634
Fertilizer							b 1,712,000	56,653
Oil							c 169,374	110,800
Cod:								
Dry-salted							b 9,829,343	773,297
Pickled							b 956,098	46,014
Frozen							b 86,971	4,209
Stockfish							b 2,900	700
Tongues							b 18,000	1,770
Whales:								
Oil							c 875,374	656,510
Sperm oil							c 377,032	276,344
Fertilizer, meat							b 2,060,000	76,420
Fertilizer, bone							b 538,000	13,472
Bone							b 13,647	2,729
Ivory							b 746	225
Meat, frozen							b 50,000	1,500
Clams							a 33,765	184,363
Trout:								
Fresh							b 80,977	9,086
Frozen							b 2,780	408
Pickled							b 2,200	165
Canned							a 371	3,496
Sable fish, fresh and frozen							b 509,369	35,485
Red rockfish							b 69,048	1,414
Crabs							d 80	160
Shrimps							b 60,000	21,000
Miscellaneous fresh fish							b 52,123	1,639
Total								50,282,067

a Cases. b Pounds. c Gallons. d Dozens.

SALMON INDUSTRY.

The situation in southeast Alaska is serious. It is certain that under present conditions, a repetition of the astounding production of 1918 could not reasonably be expected, nor could it be assumed that there would be a progressive increase in pack with the passing seasons. Fluctuations in runs, which in themselves should not be regarded as absolute indicators of conditions, will occur, but a lessened catch is not to be dismissed as an unimportant development in the situation. A diminished catch, together with an inadequate escapement of salmon to the spawning grounds, presents what may be a serious condition of the fisheries, one which should receive the careful and thoughtful attention of both the Government and the packers. It is a recognized fact that in the southeast district salmon fishery operations are becoming more intensified each season, seines and traps alike being employed in greater numbers than before, and other movable appliances being operated more assiduously as the years go by. In view of these things, it is a logical conclusion that the industry can not hold its present position, much less grow, unless some provision is made for the replenishment of the fisheries.

Central Alaska, which is of much greater extent than either of the other districts, embraces some localities that showed a greatly reduced production of salmon in 1919, while other regions yielded approximately as many fish as in 1918, but for the district as a whole there was a heavy falling off sufficient to attract more than passing notice. A comparison of the packs in 1918 and 1919 shows that the shrinkage was largely in the catch of humpback and chum salmon and that the localities most seriously affected were Prince William Sound, Cook Inlet, and Kodiak Island waters. Though the decline was felt in all sections of the district, there is less cause for concern over the situation here than elsewhere in Alaska.

The season of 1919 was markedly a failure in western Alaska. The shrinkage in production was approximately 67 per cent, and it affected both canning and pickling operations. The pack of canned salmon was the smallest that has been made since 1900 and was 62 per cent less than in 1918. On the basis that the salmon of 1919 were four-year fish, a comparison with the pack in 1915 shows a drop of 48 per cent; if they were five-year fish, a comparison with the pack in 1914 shows a decline of 58 per cent. These percentages would have been higher were it not that the pack in 1919 included 57,085 cases of Yukon River salmon, whereas the packs of 1914 and 1915 did not include any Yukon salmon.

The cause of this sudden and serious falling off in the salmon runs of western Alaska, and especially Bristol Bay, is not known, but in the absence of a better reason it may be attributed to overfishing in recent years. Apparently it was not a question of delayed runs, but seems to have been due to a real scarcity of salmon. Some persons have held that the exhaustion of the salmon fisheries is practically impossible, but to those taking a broad view of the situation this breakdown of the run of red salmon is acceptable evidence of the fallacy of any theory that the runs are impregnable.

The records of the Bristol Bay district for the last 20 years afford a basis for serious study. At first glance they show that the drain on the red-salmon run has been steadily increasing, larger numbers

of salmon being taken, with few exceptions, in the successive seasons. The pack increased from 600,000 cases in 1900 to 1,666,000 in 1918. It then dropped to 589,464 cases in 1919, a decrease of about 65 per cent. Attention has been directed in the past to these constantly increasing catches and the encroachments they meant upon the number of salmon necessary for the maintenance of the runs and the corresponding reduction of the safety quota. It may be that the packers, who seemed to be devoting all their energies to increasing production, viewed the situation too optimistically during the plenteous years and that facts of vital importance were overlooked until the sudden break in 1919 from superficially satisfactory conditions. While there may be many speculations as to the cause of the let-down in 1919, the best explanation is that it was due to overfishing. This was in substance concurred in by various salmon packers, who agreed to the necessity of further limitation by departmental regulations upon fishing at a hearing on the matter held at Seattle in November, 1919.

Operations on the Yukon River were greater than in 1918, as a pack of approximately 57,000 cases of king and chum salmon was made by the one company there established. In addition a few hundred barrels of salmon were pickled. Approximately 500,000 salmon were used in the preparation of these products. All commercial fishing was carried on below the junction of the Clear River and the Yukon, and according to the reports of operators about two-thirds of the catch of salmon was made in Bering Sea off the mouth of the Yukon.

SALMON CATCH AND FORMS OF GEAR.

The greater part of the salmon catch of Alaska is made by three kinds of apparatus, namely, seines, gill nets, and pound nets. Statistics show that a total of 800 seines were operated in 1919, aggregating in length 137,284 fathoms. This is a decrease of 38 seines from the number used in 1918, but an increase of 6,157 fathoms in the amount of seine web. There was an increase of 28 in the number of seines in southeast Alaska, and a decrease of 39 and 27 in central and western Alaska, respectively. The total number of gill nets used in the salmon industry in 1919 was 4,120, the combined length of which was 459,937 fathoms, a decrease of 19,175 fathoms in the amount of gill-net web operated in Alaska as a whole. Each district shows a decline in the use of this form of gear. In southeast Alaska there were 3,172 fathoms less than in 1918; in central Alaska, 4,552 fathoms less; and in western Alaska, 11,451 fathoms less. These decreases were due in large part to the collapse of the pickling industry.

There were operated in connection with the salmon industry 630 pound nets, of which 484 were driven and 146 were floating, or an increase of 78 over the number used in 1918. Southeast Alaska is credited with 301 driven and 143 floating traps, gains of 11 and 64, respectively; central Alaska had 172 driven traps, an increase of 6 over 1918, and 3 floating traps, the first to be used in the district; western Alaska had 11 driven traps, as against 17 in 1918, a decrease of 6.

Taking Alaska as a whole, there was an increase in the number of fathoms of seines of 4½ per cent over 1918; there was a decrease in

the number of fathoms of gill nets of 4 per cent, and an increase of 14 per cent in the number of pound nets. In 1919 seines took 36 per cent of the total catch of salmon in Alaska; pound nets 42 per cent; gill nets 19 per cent; and lines, wheels, and dip nets the remaining 3 per cent. The catch, by apparatus, in 1918 was as follows: Seines, 30 per cent; pound nets, 41 per cent; gill nets, 28 per cent; and other appliances, 1 per cent. There was an increase in the 1919 catch by seines of 6 per cent, by pound nets of 1 per cent, and a falling off in the catch by gill nets of 9 per cent. The following table shows the proportionate catch by districts according to the principal kinds of apparatus:

PERCENTAGE OF SALMON CAUGHT IN EACH ALASKA DISTRICT BY PRINCIPAL FORMS OF APPARATUS.

Apparatus.	Southeast Alaska.		Central Alaska.		Western Alaska.	
	1918	1919	1918	1919	1918	1919
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Seines	38	46	39	31	4	3
Pound nets	58	49	48	50	4	4
Gill nets	2	2	11	18	90	92

Alaska produced 58,172,665 salmon of all species in 1919 as compared with 101,454,688 in 1918, a falling off of 42½ per cent. The decrease in southeast Alaska was 12,095,965, or approximately 23½ per cent; in central Alaska, 12,681,153, or 56 per cent; and in western Alaska, 18,504,905, or 67 per cent. This is the largest shrinkage from a previous season in the yield of salmon ever reported for Alaska. In 1919, the decrease by species was 481,835 cohos, 1,981,698 chums, 22,421,386 humpbacks, and 18,637,334 reds. Kings increased 240,230.

SALMON TAKEN IN 1919, BY APPARATUS AND SPECIES, FOR EACH GEOGRAPHIC SECTION OF ALASKA.

Apparatus and species.	Southeast Alaska.	Central Alaska.	Western Alaska.	Total.
Seines:				
Coho, or silver	414,341	91,317	800	506,458
Chum, or keta	6,061,747	696,139	98,499	6,856,385
Humpback, or pink	10,459,348	736,662	13,343	11,209,353
King, or spring	9,516	2,076	4,826	16,418
Red, or sockeye	1,087,611	1,491,915	130,793	2,710,319
Total	18,032,563	3,018,109	248,261	21,298,933
Gill nets:				
Coho, or silver	335,739	61,869	103,419	501,027
Chum, or keta	249,133	87,432	586,190	922,755
Humpback, or pink	93,692	58,049	29,611	181,352
King, or spring	19,053	17,646	234,782	271,481
Red, or sockeye	401,561	1,580,602	7,232,274	9,214,437
Total	1,099,178	1,805,598	8,186,276	11,091,052
Pound nets:				
Coho, or silver	794,053	338,929	325	1,133,307
Chum, or keta	3,083,663	1,180,484	49,962	4,314,109
Humpback, or pink	13,760,123	645,287	2,681	14,408,091
King, or spring	43,963	34,863	26,944	105,770
Red, or sockeye	1,725,587	2,604,659	349,074	4,679,320
Total	19,407,389	4,804,222	428,986	24,640,597

SALMON TAKEN IN 1919, BY APPARATUS AND SPECIES, FOR EACH GEOGRAPHIC SECTION OF ALASKA—Continued.

Apparatus and species.	Southeast Alaska.	Central Alaska.	Western Alaska.	Total.
Lines:				
Coho, or silver	278,692			278,692
Chum, or keta	63,372			63,372
Humpback, or pink	96,180			96,180
King, or spring	564,606			564,606
Red, or sockeye	880			880
Total	1,003,730			1,003,730
Dip nets:				
Coho, or silver		10,362		10,362
King, or spring		3,554		3,554
Red, or sockeye		95,775		95,775
Total		109,691		109,691
Wheels:				
Chum, or keta			22,499	22,499
King, or spring			6,163	6,163
Total			28,662	28,662
Total:				
Coho, or silver	1,822,825	502,477	104.544	2,429,846
Chum, or keta	9,457,915	1,964,055	757,150	12,179,120
Humpback, or pink	24,409,343	1,439,998	45,635	25,894,976
King, or spring	637,138	58,139	272,715	967,992
Red, or sockeye	3,215,639	5,772,951	7,712,141	16,700,731
Grand total	39,542,860	9,737,620	8,892,185	58,172,665

SALMON CANNING.

CHANGES IN CANNERIES.

Several changes in the ownership of canneries were reported in 1919. In southeast Alaska, the Mountain Point Packing Co. acquired the plant of the Alaska Clam Canning Co., which ceased to operate in Alaska; the Southern Alaska Canning Co. took over the cannery of the Alaska Pacific Herring Co., at Big Port Walter, which latter concern was dissolved; the Doyhof Fish Products Co. sold its plant at Scow Bay to the G. W. Hume Co. and withdrew from Alaska. In central Alaska, the plant of the Lighthouse Canning Co., at Cordova, was sold to the Hillery-Scott Co.; the Eyak River Packing Co., operating a plant on Eyak River, was formerly the Clark-Graham Co.; and the Abercrombie Packing Co. was superseded by F. H. Madden. No change in the ownership of the latter cannery is understood to have taken place. In western Alaska, the interests of the Everett Packing Co., Phoenix Packing Co., and the Fidalgo Island Packing Co., all at Herendeen Bay, were consolidated. Their canning operations were carried on at the plant of the Fidalgo Island Packing Co. The Yukon cannery of the Carlisle Packing Co. was moved from Andreafski down to Kwiguk Slough, about 12 miles from the mouth.

NEW CANNERIES.[a]

There were 13 new salmon canneries in Alaska in 1919, 9 of which were opened and operated in southeast Alaska.

[a] New canneries are indicated by asterisks (*) in the table on page 42.

In the central district two canneries, which before 1919 were engaged in canning other sea food, began the canning of salmon, and one new plant was opened.

In western Alaska one new cannery was put in operation. The Alaska Packers Association built a cannery on the Ugashik River, but owing to the small run of salmon it was not opened, and therefore is not included in the list in 1919.

CANNERIES NOT OPERATED.

Fourteen canneries in Alaska were not operated in 1919, 9 of which were in southeast, 2 in central, and 3 in western Alaska. They were owned and located as follows:

Alaska Fisheries Co	Washington Bay.
Lane & Williams	Moira Sound.
T. E. P. Keegan	Douglas.
H. Van Vlack & Co	Thomas Bay.
Columbia Salmon Co	Craig.
Anacortes Fisheries Co	Shakan.
Northwestern Fisheries Co	Santa Ana. Hunter Bay. Roe Point. Orca. Seldovia.
Everett Packing Co	Herendeen Bay.
Phoenix Packing Co	Do.
Midnight Sun Packing Co	Kotzebue Sound.

The first 4 named above were permanently closed; the other 10 are reported as being idle rather than permanently closed.

TOTAL CANNERIES OPERATED.

In all, there were 134 salmon canneries operated in Alaska in 1919, of which number southeast Alaska had 76, central Alaska 30, and western Alaska 28. There was no change in the number credited to the southeast district; the central district gained 1; and the western district lost 2.

COMPANIES CANNING SALMON IN ALASKA, NUMBER AND LOCATION OF CANNERIES OPERATED, AND NUMBER OF POUND NETS OWNED BY EACH, 1919.

[New canneries indicated by *.]

Company.	Canneries. Number.	Canneries. Location.	Pound nets.
Southeast Alaska:			
Alaska Fish Co	1	Waterfall	
Alaska Herring & Sardine Co	1	Port Walter	[a] 20
Alaska Pacific Fisheries	3	Chilkoot	[b] 11
		Chomly	[c] 8
		Yes Bay	[d] 13
Alaska Packers Association	2	Loring	[e] 11
		Wrangell	[e] 6
Alaska Packing & Navigation Co	1	Pavlof Harbor	
Alaska Salmon & Herring Packers (Inc.)	1	Tyee *	
Alaska Sanitary Packing Co	2	Cape Fanshaw *	
		Wrangell	5
American Packing Co	1	Juneau	[b] 2
Anacortes Fisheries Co	1	Kasaan	8
Annette Island Packing Co	1	Metlakatla	7

[a] 17 floating. [b] 1 floating. [c] 4 floating. [d] 9 floating. [e] 5 floating.

COMPANIES CANNING SALMON IN ALASKA, NUMBER AND LOCATION OF CANNERIES OPERATED, AND NUMBER OF POUND NETS OWNED BY EACH, 1919—Continued.

Company.	Canneries. Number.	Canneries. Location.	Pound nets.
Southeast Alaska—Continued.			
Astoria & Puget Sound Canning Co	1	Excursion Inlet	a 13
Auk Bay Salmon Canning Co	1	Auk Bay	6
Baranof Packing Co	1	Red Bluff Bay	
Barnes, F. C., Co	1	Lake Bay	2
Beauclaire Packing Co	1	Port Beauclerc *	1
Beegle Packing Co	1	Ketchikan	a 5
Burnett Inlet Packing Co	1	Burnett Inlet	b 5
Cape Fanshaw Fish & Packing Co. (Inc.)	1	Cape Fanshaw *	
Carlson, John L., & Co	1	Auk Harbor *	b 3
Cole, R. L	1	Deweyville	1
Columbia Salmon Co	1	Tenakee	
Deep Sea Salmon Co	2	Ford Arm	b 9
		Port Althorp	b 20
Douglas Island Packing Co	1	Douglas Island *	
Fidalgo Island Packing Co	2	Ketchikan	c 9
		Pillar Bay	7
George Inlet Packing Co	1	George Inlet	2
Haines Packing Co	1	Letinkof Cove	
Harris, P. E., & Co	1	Hawk Inlet	
Hidden Inlet Canning Co	2	Hidden Inlet	d 5
		Hood Bay	5
Hood Bay Packing Co	1	Hood Bay*	
Hoonah Packing Co	2	Gambier Bay	a 13
		Hoonah	e 17
Hume, G. W., Co	2	Nakat Harbor	7
		Scow Bay	4
Karheen Packing Co	1	Karheen	5
Ketchikan Packing Co	1	Ketchikan	
Libby, McNeill & Libby	2	Taku Harbor	16
		Yakutat	
Marathon Fishing & Packing Co	1	Cape Fanshaw	b 3
Mountain Point Packing Co	1	Wrangell Narrows	
Myers, Geo. T., & Co	1	Chatham	10
Northern Packing Co. (Inc.)	1	Juneau	
North Pacific Trading & Packing Co	1	Klawak	
Northwestern Fisheries Co	2	Dundas Bay	d 10
		Quadra	d 11
Noyes Island Packing Co	1	Steamboat Bay	
Olympic Fisheries Co	1	(Floating)*	
Pacific American Fisheries	1	Excursion Inlet	d 16
Petersburg Packing Corporation	2	Petersburg	a 10
		Washington Bay*	a 6
Point Warde Packing Co	1	Point Warde	
Pure Food Fish Co	1	Ketchikan	c 4
Pybus Bay Fish & Packing Co	1	Pybus Bay	
Pyramid Packing Co	1	Sitka	2
Sanborn-Cutting Co	1	Kake	b 8
Sitka Packing Co	1	Sitka	
Smiley, J. L., & Co	1	Ketchikan	5
Southern Alaska Canning Co	3	Big Port Walter	b 5
		Quadra Bay	a 5
		Rose Inlet	4
Starr-Collinson Packing Co	1	Moira Sound	b 2
Straits Packing Co	1	Skowl Arm	
Sunny Point Packing Co	1	Ketchikan	7
Swift-Arthur-Crosby Co	1	Heceta Island	c 6
Tee Harbor Packing Co	1	Tee Harbor	a 9
Tenakee Fisheries Co	1	Tenakee Inlet	c 7
Thlinket Packing Co	1	Funter	f 21
Todd Packing Co	1	Peril Strait	c 6
Union Bay Fisheries Co	1	Union Bay	4
Ward's Cove Packing Co	1	Ward Cove	
Central Alaska:			
Alaska Packers' Association	4	Alitak	5
		Chignik	4
		Kasilof	16
		Larsen Bay	
Alaska Sea Food Co	1	Cordova	c 2
Alitak Packing Co	1	Lazy Bay	2
Canoe Pass Packing Co	1	Shepard Point	a 4
Carlisle Packing Co	1	Cordova	10
Columbia River Packers' Association	1	Chignik	6
Copper River Packing Co	1	Port Nellie Juan	5
Eyak River Packing Co	1	Eyak River	

a 2 floating.
b All floating.
c 1 floating.
d 3 floating.
e 5 floating.
f 4 floating.

COMPANIES CANNING SALMON IN ALASKA, NUMBER AND LOCATION OF CANNERIES OPERATED, AND NUMBER OF POUND NETS OWNED BY EACH, 1919—Continued.

Company.	Canneries. Number.	Canneries. Location.	Pound nets.
Central Alaska—Continued.			
F. H. Madden	1	Abercrombie	....
Fidalgo Island Packing Co	1	Port Graham	4
Franklin Packing Co	1	Sawmill Bay *	7
Hillery-Scott Co	1	Cordova	2
Hoonah Packing Co	1	Katalla	1
Kadiak Fisheries Co	1	Kodiak	1
Kenai Packing Co	1	Drier Bay	3
Libby, McNeill & Libby	1	Kenai	18
Moore Packing Co	1	Orca Inlet	2
Northwestern Fisheries Co	3	Chignik	4
		Kenai	16
		Uyak	....
Pacific American Fisheries	2	Ikatan	18
		King Cove	18
Pioneer Packing Co	1	Cordova *	4
San Juan Fishing & Packing Co	1	Seward	2
Sockeye Salmon Co	1	Morzhovoi Bay	4
Surf Packing Co	1	Tuxedni Harbor *	1
Valdez Packing Co	1	Valdez	4
Western Alaska:			
Alaska Packers' Association	8	Kvichak River (2)	....
		Naknek River (3)	....
		Nushagak Bay (2)	4
		Ugaguk River	....
Alaska-Portland Packers' Association	2	Naknek *	....
		Nushagak Bay	3
Alaska Salmon Co	1	Wood River	....
Bristol Bay Packing Co	1	Kvichak River	....
Carlisle Packing Co	1	Kwiguk Slough	1
Columbia River Packers' Association	1	Nushagak Bay	....
Herendeen Bay Consolidated Canneries	1	Herendeen Bay	....
Libby, McNeill & Libby	6	Ekuk	....
		Kvichak Bay (Koggiung)	....
		Libbyville	....
		Lockanok	....
		Nushagak	....
		Ugaguk River	....
Naknek Packing Co	1	Naknek River	....
Nelson Lagoon Packing Co	1	Nelson Lagoon	....
Northwestern Fisheries Co	2	Naknek River	....
		Nushagak	....
Pacific American Fisheries	1	Port Moller	....
Red Salmon Canning Co	2	Naknek River	....
		Ugashik River	....

STATISTICS.

The number of salmon canneries in operation in Alaska in 1919 was 134, one less than in 1918. The investment in the salmon-canning industry was $66,495,171, an increase of $2,593,774. The southeast district shows an increase of $4,770,765; the central district, an increase of $937,266; and the western district, a decrease of $3,114,257.

In 1919, the canning industry gave employment to 25,499 persons, or 1,003 less than the number employed in 1918. Whites increased 74, Chinese 36, Filipinos 239, and Mexicans 157. Natives decreased 1,124, Japanese 34, and miscellaneous 351.

A total of 4,583,688 cases of salmon, valued at $43,265,349, was packed in Alaska in 1919, a decrease in pack of 2,022,147 cases and in value of $7,776,600 from the production of 1918. This is a drop of 30½ per cent in output and 15 per cent in value from the high records of 1918. Perhaps for the first time in the history of salmon canning in Alaska each district shows a smaller pack than was

made in the preceding year. Comparing the 1918 pack with that of 1919, southeast Alaska dropped from 3,375,445 cases to 3,119,260, a decrease of 256,185 cases; central Alaska, from 1,391,951 to 771, 907 a decrease of 620,044 cases; and western Alaska, from 1,838,439 to 692,521, a decrease of 1,145,918 cases. Comparing the pack by species for 1918 and 1919, it is found that cohos increased from 218,958 to 232,870 cases, a gain of 13,912 cases; chums increased from 1,364,960 to 1,365,563 cases, a gain of 603 cases; humpbacks dropped from 2,438,954 to 1,611,608 cases, a decrease of 827,346 cases; kings increased from 49,226 to 95,986 cases, an increase of 46,760 cases; and reds dropped from 2,533,737 to 1,277,661 cases, a decrease of 1,256,076 cases.

INVESTMENT, PERSONS ENGAGED, AND PRODUCTS OF ALASKA SALMON-CANNING INDUSTRY IN 1919.

Item.	Southeast Alaska.		Central Alaska.		Western Alaska.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
INVESTMENT.								
	No.		No.		No.		No.	
Canneries operated	76	$6,860,381	30	$2,606,786	29	$5,101,559	135	$14,568,726
Working capital		13,445,847		4,570,887		6,674,595		24,691,329
Wages paid		7,012,062		2,511,223		3,991,311		13,514,596
Vessels:								
Power vessels over 5 tons	358	2,374,186	100	1,009,051	77	1,145,325	535	4,528,562
Net tonnage	6,635		2,711		7,015		16,361	
Launches under 5 tons	147	157,114	149	152,458	43	201,847	339	511,419
Sailing	2	54,000	8	323,500	33	1,118,010	43	1,495,510
Net tonnage	2,954		12,389		45,982		61,325	
Barges	3	35,086					3	35,086
Net tonnage	3,295						3,295	
Rowboats and skiffs	1,242	104,093	821	124,413	1,458	629,438	3,521	857,944
Lighters, scows, and houseboats	392	332,193	246	257,133	185	369,176	823	958,502
Pile drivers	61	390,184	43	188,604	24	64,605	128	643,393
Apparatus:								
Haul seines	188	92,024	113	39,161			301	131,185
Fathoms	22,510		16,265				38,775	
Purse seines	396	331,368	72	32,991	22	39,200	490	403,559
Fathoms	75,140		17,069		5,700		97,909	
Gill nets	270	52,283	1,071	119,255	2,633	482,317	3,974	653,855
Fathoms	45,875		77,211		328,098		451,184	
Pound nets driven	292	2,161,187	172	953,348	11	37,000	475	3,151,535
Pound nets, floating	142	339,241	3	8,700			145	347,941
Dip nets			35	437			35	437
Fish wheels	1	642			6	950	7	1,592
Total		33,741,891		12,897,947		19,855,333		66,495,171
PERSONS ENGAGED.								
Fishermen:								
Whites	1,781		1,135		3,028		5,944	
Natives	1,376		282		61		1,719	
Filipinos	41						41	
Mexicans	28						28	
Miscellaneous [a]	56						56	
Total	3,282		1,417		3,089		7,788	
Shoresmen:								
Whites	3,258		1,151		2,064		6,473	
Natives	1,173		493		213		1,879	
Chinese	1,366		536		868		2,770	
Japanese	928		266		237		1,431	
Filipinos	878		279		379		1,536	
Mexicans	204		250		1,384		1,838	
Miscellaneous [a]	151		37		275		463	
Total	7,958		3,012		5,420		16,390	

[a] Koreans, Porto Ricans, Kanakas, Negroes, etc.

INVESTMENT, PERSONS ENGAGED, AND PRODUCTS OF ALASKA SALMON CANNING INDUSTRY IN 1919—Continued.

Item.	Southeast Alaska.		Central Alaska.		Western Alaska.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
PERSONS ENGAGED—continued.								
Transporters:	*No.*		*No.*		*No.*		*No.*	
Whites	774	....	251	....	226	....	1,251	....
Natives	14	....	19	....	3	....	36	....
Miscellaneous [a]	23	....	6	....	5	....	34	....
Total	811	....	276	....	234	....	1,321	....
Grand total:								
Whites	5,813	....	2,537	....	5,318	....	13,668	....
Natives	2,563	....	794	....	277	....	3,634	....
Chinese	1,366	....	536	....	868	....	2,770	....
Japanese	928	....	266	....	237	....	1,431	....
Filipinos	919	....	279	....	379	....	1,577	....
Mexicans	232	....	250	....	1,384	....	1,866	....
Miscellaneous [a]	230	....	43	....	280	....	553	....
Total	12,051	....	4,705	....	8,743	....	25,499	....
PRODUCTS.[b]								
Coho, or silver:	*Cases.*		*Cases.*		*Cases.*		*Cases.*	
½-pound flat	8,597	$130,524	910	$10,926	212	$3,400	9,719	$144,850
1-pound flat	10,359	128,680	....	....	79	995	10,438	129,675
1-pound tall	150,558	1,661,074	54,831	601,210	7,324	88,017	212,713	2,350,301
Total	169,514	1,920,278	55,741	612,136	7,615	92,412	232,870	2,624,826
Chum, or keta:								
½-pound flat	3,981	33,209	....	....	....	....	3,981	33,209
1-pound tall	1,141,744	7,706,656	160,222	1,084,132	59,616	496,459	1,361,582	9,287,247
Total	1,145,725	7,739,865	160,222	1,084,132	59,616	496,459	1,365,563	9,320,456
Humpback, or pink:								
½-pound flat	27,990	286,607	195	1,835	....	....	28,185	288,442
1-pound flat	7,553	58,700	....	....	....	....	7,553	58,700
1-pound tall	1,488,979	12,420,147	86,449	698,213	442	3,544	1,575,870	13,121,904
Total	1,524,522	12,765,454	86,644	700,048	442	3,544	1,611,608	13,469,046
King, or spring:								
½-pound flat	2,670	45,459	2,378	44,791	2,536	46,797	7,584	137,047
1-pound flat	2,002	27,981	640	8,052	8,890	132,803	11,532	168,836
1-pound tall	25,609	295,042	9,325	108,113	41,936	552,019	76,870	955,174
Total	30,281	368,482	12,343	160,956	53,362	731,619	95,986	1,261,057
Red, or sockeye:								
½-pound flat	53,620	902,247	44,639	755,947	23,977	379,430	122,236	2,037,624
1-pound flat	43,960	589,979	43,487	511,117	23,044	294,405	110,491	1,395,501
1-pound tall	151,638	1,936,763	368,831	4,522,995	524,465	6,697,081	1,044,934	13,156,839
Total	249,218	3,428,989	456,957	5,790,059	571,486	7,370,916	1,277,661	16,589,964
Grand total	3,119,260	26,223,068	771,907	8,347,331	692,521	8,694,950	4,583,688	43,265,349

[a] Koreans, Porto Ricans, Kanakas, Negroes, etc.

[b] Cases containing ½-pound cans have been reduced one-half in number, and thus, for the purpose of affording fair comparison, all are put upon the basis of 48 1-pound cans per case.

Output of Canned Salmon in Alaska, 1913 to 1919.[a]

Product.	1913	1914	1915	1916	1917	1918	1919	Total.
Coho, or silver:	*Cases.*	*Cases.*	*Cases.*	*Cases.*	*Cases.*	*Cases.*	*Cases.*	*Cases.*
½-pound flat	3,587	4,579	2,050	13,145	30,412	26,238	9,719	89,730
1-pound flat	266	285	2,338	8,191	362	12,786	10,438	34,666
1-pound tall	71,926	152,199	119,880	240,573	162,457	179,934	212,713	1,139,682
Total	75,779	157,063	124,268	261,909	193,231	218,958	232,870	1,264,078
Chum, or keta:								
½-pound flat	985	373	....	1,423	26,760	3,559	3,981	37,081
1-pound flat	2,619	5,568	317	....	2,530	2,996	....	14,030
1-pound tall	287,314	657,918	479,629	722,692	877,457	1,358,405	1,361,582	5,744,997
Total	290,918	663,859	479,946	724,115	906,747	1,364,960	1,365,563	5,796,108
Humpback, or pink:								
½-pound flat	20,822	2,103	4,325	41,491	91,403	63,557	28,185	251,886
1-pound flat	3,258	9,286	3,508	14,796	6,014	20,215	7,553	64,630
1-pound tall	1,348,801	974,660	1,867,683	1,681,506	2,199,559	2,355,182	1,575,870	12,003,261
Total	1,372,881	986,049	1,875,516	1,737,793	2,296,976	2,438,954	1,611,608	12,329,777
King, or spring:								
½-pound flat	1,585	3,143	2,404	2,617	12,973	6,000	7,584	36,306
1-pound flat	....	4,804	3,755	3,804	5,133	5,267	11,532	34,295
1-pound tall	32,785	40,092	82,092	59,452	43,845	37,959	76,870	373,095
Total	34,370	48,039	88,251	65,873	61,951	49,226	95,986	443,696
Red, or sockeye:								
½-pound flat	29,041	53,825	52,033	81,565	124,309	137,008	122,236	600,017
1-pound flat	11,735	64,671	112,847	86,395	89,612	151,864	110,491	627,615
1-pound tall	1,924,461	2,083,147	1,765,139	1,936,971	2,274,460	2,244,865	1,044,934	13,273,977
1½-pound nominals	....	....	2,293	....	....	....	....	2,293
2-pound nominals	....	....	....	6,006	....	....	....	6,006
Total	1,965,237	2,201,643	1,932,312	2,110,937	2,488,381	2,533,737	1,277,661	14,509,908
Grand total	3,739,185	4,056,653	4,500,293	4,900,627	5,947,286	6,605,835	4,583,688	34,333,567

[a] The number of cases shown has been put upon the common basis of 48 1-pound cans per case.

Average Annual Price per Case of 48 1-Pound Cans of Salmon, 1909 to 1919.

Product.	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919
Coho, or silver	$4.07	$4.89	$5.67	$4.44	$3.45	$4.39	$4.31	$5.34	$8.76	$9.15	$11.27
Chum, or keta	2.28	3.04	3.72	2.37	2.21	3.37	2.59	3.34	6.14	6.27	6.82
Humpback, or pink	2.40	3.15	3.94	2.55	2.58	3.50	2.78	3.64	6.44	6.58	8.35
King, or spring	4.32	5.34	6.48	5.37	4.04	5.01	4.63	5.36	10.40	9.85	13.13
Red, or sockeye	4.53	5.30	6.33	5.45	4.54	5.58	5.82	6.04	9.48	9.44	12.98

LOSSES AND DISASTERS IN SALMON-CANNING INDUSTRY.

The heaviest losses of property in the salmon-canning industry occurred in southeast Alaska, the largest single item being the cannery of the Alaska Pacific Fisheries, at Chilkoot, which, with its contents, was destroyed by fire on June 8, 1919. The buildings were valued at $20,502 and the contents, composed largely of gear and supplies for the season's operations, at $33,445, thus making a total loss of $53,947. Further losses in the same district were small buildings valued at $6,822, boats and floating equipment at $19,123, and gear at $12,448. The total of all reported property losses in southeast Alaska was $92,340.

In central Alaska a fire at the cannery of the Carlisle Packing Co., at Cordova, destroyed a web house and contents, the combined value of which was $30,144. Additional losses in that district consisted of miscellaneous small buildings valued at $2,000, scows and boats at $5,657, and gear at $7,550. In all, property valued at $45,351 was lost in central Alaska.

Losses in western Alaska aggregated $11,770, of which amount $4,450 represented the value of floating property, including the schooner *Premier* (292 tons net), which belonged to the Alaska Packers' Association, and was wrecked off the southern coast of the Alaska Peninsula while making the voyage from San Francisco to Bristol Bay. Small buildings and wharfs valued at $2,200 and gear valued at $5,120 constitute the other losses of property in western Alaska.

The value of all property lost in Alaska in connection with salmon canning in 1919 was $149,461.

Thirteen lives were lost in this industry. In southeast Alaska one fisherman was drowned and three shoresmen were killed; in central Alaska one fisherman and one shoresman were killed; and in western Alaska two fishermen were killed and three fishermen, one shoresman, and one transporter were drowned.

MILD CURING OF SALMON.

The mild-cure salmon industry shows a marked advance in 1919 over that reported in 1918. It was centered almost exclusively in southeast Alaska, the investment being credited wholly to that district. A total of 5,376 tierces of salmon was mild cured in Alaska in 1919, an increase of 1,428 tierces over the production in 1918. Of this number, 5,194 tierces were packed in southeast Alaska, 7 in central and 175 in the western district. There were more than 30 packers of mild-cured salmon, chief among which were the following concerns:

Goemaere Fish Co. (Inc.)	Washington Bay.
Pacific Mild Cure Co	Tyee. Port Conclusion. Port Alexander. Waterfall. Ketchikan. Cape Fanshaw. 3 floating plants.
Columbia & Northern Fishing & Packing Co	Wrangell.
Vendsyssel Packing Co	Tyee.
H. R. Thompson	Ketchikan.
Columbia Salmon Co	Tenakee.
M. B. Dahl & Co	Floating plant.

INVESTMENT, PERSONS ENGAGED, AND PRODUCTS OF ALASKA SALMON MILD CURING INDUSTRY IN 1919.

Item.	Tierces.	Number.	Value.
INVESTMENT.[a]			
Plants	....	11	$89,388
Operating capital	....	....	547,006
Vessels:			
Power vessels over 5 tons	....	23	86,888
Net tonnage	....	407	....
Barges	....	1	3,000
Net tonnage	....	176	....
Launches under 5 tons	....	9	5,124
Rowboats and skiffs	....	10	347
Lighters and scows	....	4	9,850
Apparatus:			
Lines	....	4	32
Total	....	....	741,635
PERSONS ENGAGED.[a]			
Fishermen:			
Whites	....	2	....
Shoresmen:			
Whites	....	101	....
Natives	....	8	....
Japanese	....	1	....
Total	....	110	....
PERSONS ENGAGED—continued			
Transporters:			
Whites	....	21	....
Grand total	....	133	....
PRODUCTS.			
Southeast Alaska:		*Pounds.*	
Coho salmon	28	22,600	$4,656
Chum salmon	2	1,600	140
King salmon	5,164	4,130,800	874,879
Total	5,194	4,155,000	879,675
Central Alaska:			
King salmon	7	5,600	950
Western Alaska:			
King salmon	175	140,000	36,175
Grand total	5,376	4,290,600	916,800

[a] Southeast Alaska only.

SALMON PICKLING.

The salmon-pickling industry of Alaska in 1919 shows a general shrinkage in all directions from the high figures of 1918 and in such proportions as to be little less than a collapse of the industry. In comparing the records of 1918 with those of 1919, some interesting facts are disclosed. Southeast Alaska had 7 plants in 1918 as against none in 1919, and an investment of $278,306 in 1918, as against none in 1919; central Alaska had 2 salteries in 1919 as against 9 in 1918, and investments of $236,261 in 1919 as compared with $492,160 in 1918; western Alaska had 9 salteries in 1919 as against 11 in 1918, and investments of $354,161, as compared with $592,491 in 1918. There was a total decrease of 16 salteries and a smaller investment by $772,535.

The reported pack of pickled salmon was 8,110 barrels, valued at $195,447, as compared with 56,890 barrels in 1918, valued at $1,079,881. All pickling operations in southeast Alaska in 1919 were incidental to more important undertakings, while a considerable part of the pack in central and western Alaska was prepared by concerns engaged chiefly in other fishery activities, particularly salmon canning. The most important packers in the respective districts were as follows: Southeast Alaska, Pacific Mildcure Co. and Columbia & Northern Fishing & Packing Co.; central Alaska, Shumagin Packing Co. and Universal By-Products Co.; western Alaska, Alaska Packers Association, Bering Sea Salmon Packing Co., Golden Gate Salmon Co., Libby McNeill & Libby, Peter M. Nelson, and Alaska Salmon Co.

One noteworthy change in the ownership of salteries occurred in western Alaska when the plant of Olson Bros., at Koggiung, was sold to the Bering Sea Salmon Packing Co., of San Francisco.

Losses in the salmon-pickling industry were small, consisting wholly of miscellaneous gear, valued at $3,550.

INVESTMENT, PERSONS ENGAGED, AND PRODUCTS OF ALASKA SALMON-PICKLING INDUSTRY IN 1919.

Item.	Southeast Alaska.		Central Alaska.		Western Alaska.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
INVESTMENT.	No.		No.		No.		No.	
Salteries			2	$36,955	9	$102,750	11	$139,705
Operating capital				129,736		131,346		261,082
Vessels:								
Power vessels over 5 tons			2	11,000	3	23,000	5	34,000
Net tonnage			16		57		73	
Sailing					3	49,725	3	49,725
Net tonnage					991		991	
Launches under 5 tons					9	16,800	9	16,800
Rowboats and skiffs			32	1,920	47	10,015	79	11,935
Lighters and scows					5	6,800	5	6,800
Pile driver					1	2,000	1	2,000
Apparatus:								
Haul seines					7	800	7	800
Fathoms					300		300	
Purse seines			1	2,800			1	2,800
Fathoms			200				200	
Gill nets			14	3,850	110	10,225	124	14,075
Fathoms			1,050		6,438		7,488	
Pound nets, driven			5	50,000			5	50,000
Wheels					2	700	2	700
Total				236,261		354,161		590,422
PERSONS ENGAGED.								
Fishermen:								
Whites			38		66		104	
Natives			1		22		23	
Total			39		88		127	
Shoresmen:								
Whites			18		59		77	
Natives			6		1		7	
Mexicans					25		25	
Total			24		85		109	
Transporters:								
Whites			21		8		29	
Natives					2		2	
Total			21		10		31	
Grand total			84		183		267	
PRODUCTS.[a]	Barrels.		Barrels.		Barrels.		Barrels.	
Coho, or silver	706	$13,206	204	3,024	292	5,918	1,202	22,148
Chum, or keta	70	2,080	27	135	41	555	138	2,770
Humpback, or pink	26	260	50	700	45	548	121	1,508
King, or spring	241	4,542	8	232	618	16,267	867	21,041
Red, or sockeye	12	355	587	12,380	5,183	135,245	5,782	147,980
Total	1,055	20,443	876	16,471	6,179	158,533	8,110	195,447

[a] Each barrel holds 200 pounds of fish.

SALMON FREEZING.

The output of frozen salmon from Alaska in 1919 was prepared by six companies in southeastern Alaska engaged primarily in the freezing of halibut and the canning of salmon. For that reason, no investment is credited to this business and no persons are shown as employed therein. The companies referred to were as follows: Booth Fisheries Co., Goemaere Fish Co. (Inc.), Juneau Cold Storage Co., Libby, McNeill & Libby, National Independent Fisheries Co., New England Fish Co.

There was produced in Alaska in 1919 a total of 1,552,480 pounds of frozen salmon, valued at $130,355, a decrease from 1918 of 325,442 pounds in production and of $40,509 in value.

QUANTITY AND VALUE OF SALMON FROZEN IN ALASKA IN 1919, BY SPECIES.

Species.	Pounds.	Value.
Coho, or silver	254,784	$27,022
Chum, or keta	437,878	28,651
Humpback, or pink	356,680	17,834
King, or spring	396,213	46,156
Red, or sockeye	106,925	10,692
Total	1,552,480	130,355

FRESH-SALMON TRADE.

The fresh-salmon trade of Alaska in 1919 was confined wholly to the southeast district. Nearly all of this business was incidental to the canning and mild-curing industry, there being only three firms whose chief trade was dealing in fresh salmon. They were Knutsen Bros., at West Point, and H. Bergman and the Fresh Fish Co., both at Ketchikan. The quantity of salmon sold fresh in Alaska in 1919 was reported as 5,208,327 pounds, valued at $356,688. This is an increase in production of 947,412 pounds, and in value of $20,112.

INVESTMENT, PERSONS ENGAGED, AND PRODUCTS OF ALASKA FRESH-SALMON TRADE IN 1919.[a]

Item.	Quantity.	Value.	Item.	Quantity.	Value.
INVESTMENT.	*Number.*		PERSONS ENGAGED.		
Operating capital		$27,685	Fishermen: Whites	16	
Wages paid		27,581	Shoresmen: Whites	8	
Launches	2	2,800	Transporters: Whites	10	
Rowboats	11	470			
Seines, haul (100 fathoms)	1	150	Total	34	
Gillnets (105 fathoms)	2	150			
Pound nets, driven	4	43,000	PRODUCTS.		
Pound nets, floating	1	2,500		*Pounds.*	
			Coho, or silver	1,306,698	$71,694
Total		104,336	Chum, or keta	420,722	15,334
			Humpback, or pink	450,429	9,703
			King, or spring	2,695,854	242,756
			Red, or sockeye	334,624	17,201
			Total	5,208,327	356,688

[a] Confined wholly to southeast Alaska in 1919.

DRY SALTING OF SALMON.

The dry salting of salmon in Alaska in 1919 was represented by the activities of a single packer, the Kuskokwim Fishing & Transportation Co., at Apokak. The investment was increased from $58,345 in 1918 to $103,862 in 1919, the increase being accounted for entirely by the inclusion of the value of certain vessels not reported in 1918.

INVESTMENT, PERSONS ENGAGED, AND PRODUCTS OF ALASKA DRY SALTING OF SALMON IN 1919.[a]

Item.	Quantity.	Value.	Item.	Quantity.	Value.
INVESTMENT.			PERSONS ENGAGED—cont.		
	Number.				
Plants	1	$10,000	Shoresmen:	*Number.*	
Operating capital	....	29,162	Whites	3	....
Power vessels over 5 tons	4	63,000	Natives	25	....
Net tonnage	423	....	Transporters:		
Launches	1	200	Whites	1	....
Seine and rowboats	16	900			
Gill nets, 1,160 fathoms	20	600	Total	39	....
Total	....	103,862	PRODUCTS.		
				Pounds.	
PERSONS ENGAGED.			Coho, or silver	71,670	$7,167
			Chum, or keta	15,104	1,359
Fishermen:			King, or spring	110,820	7,757
Whites	10	....	Red, or sockeye	14,650	1,318
			Total	212,244	17,601

[a] Confined wholly to western Alaska.

DRYING AND SMOKING OF SALMON.

The drying and smoking of salmon in Alaska is not an essential branch of the salmon industry, though a considerable quantity of salmon is doubtless so prepared and used locally, chiefly by the Indians. Statistics of the number of salmon used in this way are unavailable, but a conservative estimate would place the quantity at 400,000 pounds, having a value of at least $40,000. In addition to this, the Juneau Cold Storage Co. kippered 15,000 pounds of salmon, valued at $3,000.

SALMON BY-PRODUCTS.

The most notable change in the salmon by-products industry was the withdrawal from Alaska of the Fish Canners By-Products Co., at Ward Cove. This company met with misfortune in 1918 by the loss in transit of new machinery intended for installation in its oil and fertilizer factory, and as a result it decided not to operate. The plant was then offered for sale and remained idle in 1919.

The Pacific American Fisheries was the only concern in Alaska in 1919 utilizing the offal and other fishery waste at its canneries in the production of by-products. It operated plants in connection with the canneries at Excursion Inlet in southeast Alaska, and at Ikatan in central Alaska. As these reduction plants were incidental to the canning of salmon, no investment in the by-products industry is shown for 1919. The products were 362 tons of fertilizer, valued at $18,680, and 966 gallons of oil, valued at $966.

HALIBUT FISHERY.

The large halibut banks of the North Pacific Ocean are located largely in extraterritorial waters. They are fished by vessels from Seattle, Prince Rupert, and Alaskan ports, to which places fares are delivered. There are also large banks off the coast of British Columbia, Washington, and Oregon, which are visited by these same vessels. The impracticability of making the necessary segregation of catches, in order to show how much of the total production of halibut from the Pacific Ocean should be credited to the respective regions, is at once obvious. The statistics appearing herein include all catches delivered at ports in Alaska and at Seattle by American vessels fishing on Yakutat, Portlock, Albatross, and the banks adjacent to the coast of southeast Alaska. A total of 14,278,791 pounds is thus accounted for. American vessels also delivered at Prince Rupert and Vancouver a total of 11,761,750 pounds of halibut which in all probability came largely from the Alaskan banks.

STATISTICAL SUMMARY.

The investment in the halibut industry in 1919 was $1,979,457, as against $2,594,292 in 1918, a falling off of $614,835. The industry gave employment to 867 persons as compared with 1,186 in 1918, a decrease of 319. Production increased from 13,869,706 pounds in 1918 to 14,278,791 pounds in 1919, a total of 409,085 pounds. Values dropped from $1,667,686 to $1,550,605, a decline of $117,081.

The principal handlers of halibut were Libby, McNeill & Libby, at Taku; New England Fish Co., at Ketchikan; Alaska Fish & Cold Storage Co., successor to the Glacier Fish Co., at Scow Bay; Booth Fisheries Co., at Sitka; Juneau Cold Storage Co., at Juneau; National Independent Fisheries Co., at Juneau; Ripley Fish Co., at Ketchikan, Wrangell, and Petersburg; and the San Juan Fishing & Packing Co., at Seward.

One fisherman was drowned while engaged in halibut fishing. Minor property losses aggregating in value $10,000 were also reported.

INVESTMENT, PERSONS ENGAGED, AND PRODUCTS OF ALASKA HALIBUT FISHERY IN 1919.

Item.	Quantity.	Value.	Item.	Quantity.	Value.
INVESTMENT.			PERSONS ENGAGED.		
Fishing vessels:	*Number.*			*Number.*	
Steam and gas	94	$1,140,900	Whites	863	
Net tonnage	1,957		Natives	3	
Outfit		560,000	Japanese	1	
Launches	5	11,451	Total	867	
Dories and scows	192	10,200	PRODUCTS.		
Fishing apparatus		51,550		*Pounds.*	
Shore property		205,356	Fresh (including local)	7,783,179	$880,433
Total		1,979,457	Frozen	6,495,372	670,147
			Canned	240	25
			Total	14,278,791	1,550,605

HERRING FISHERY.

The herring industry of Alaska suffered a decided setback in 1919, due to a weaker demand for Alaska pickled herring. Packers experienced great delay in marketing their products, the explanation being that the importation of European herring had closed the large eastern markets to the Scotch-cured herring from Alaska, and that the Norwegian-cured herring from Alaska were virtually unsalable. A further reason may be given for this unsatisfactory condition, namely, faulty packing and poor selection, both of which are matters wholly within the control of the packers. Any difficulty they encountered in the disposal of herring so packed may be easily understood. If the industry is to survive and expand, it is imperative that goods of high standard be produced regardless of method of cure.

A review of operations in 1919 would indicate that packers recognized the fact that Scotch-cured herring are preferred in American markets to those of any other cure. This is evidenced by the statistics for that year, which show that the bulk of the pack was prepared according to the Scotch formula, though the total production was considerably less than in 1918.

STATISTICAL SUMMARY.

The investment in the herring industry in 1919 was $900,572, a decrease of more than 50 per cent from the amount reported in 1918. This was partly due to a change in classification of some operators, but a further cause was the failure of a number of packers to resume operations in 1919. The number of persons employed was 427, or approximately 50 per cent less than in 1918, when 884 were reported. The herring products in 1919 were valued at $1,676,170, as compared with $1,819,538 in 1918, a decrease of $143,368. Canned herring was the leading product, representing in value more than 50 per cent of the total output. Scotch-cured herring took second place, although there was a decline in production of 20 per cent and a shrinkage in value of approximately 40 per cent from 1918. The production of Norwegian-cured herring dropped to 11,080 barrels, or a falling off in output of 73 per cent as compared with the pack in 1918.

Losses in the herring industry aggregated $7,360, of which amount $2,600 represented the value of apparatus and other equipment, and $4,760 the value of 281 barrels of pickled herring.

INVESTMENT, PERSONS ENGAGED, AND PRODUCTS OF ALASKA HERRING FISHERY IN 1919.

Item.	Southeast Alaska.		Central Alaska.		Western Alaska.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.
INVESTMENT.								
Plants operated	4	$98,192	6	$92,491	1	$12,000	11	$202,683
Operating capital		224,866		257,550		24,283		506,699
Vessels:								
Power vessels over 5 tons	8	41,500	8	37,300	1	6,500	17	85,300
Net tonnage	195		134		11		340	
Launches under 5 tons	2	6,592	5	7,500	1	1,000	8	15,092
Boats, row and seine	22	1,860	26	1,375	11	1,000	59	4,235
Lighters and scows	8	12,500	8	9,700	2	350	18	22,550
Pile driver	1	1,500					1	1,500
Apparatus:								
Haul seines	6	10,500	10	13,077	2	530	18	24,107
Fathoms	560		1,685		200		2,445	
Purse seines	10	21,061	3	8,000	6	3,500	19	32,561
Fathoms	1,230		490		600		2,320	
Gill nets			14	1,860	100	1,500	114	3,360
Fathoms			700		1,700		2,400	
Dip nets			2	10			2	10
Pound nets			6	2,475			6	2,475
Total		418,571		431,338		50,663		900,572
PERSONS ENGAGED.								
Fishermen:								
Whites	67		38		5		110	
Natives	3		9		16		28	
Others	5		16				21	
Total	75		63		21		159	
Shoresmen:								
Whites	58		86		6		150	
Natives	7		24		71		102	
Others	11						11	
Total	76		110		77		263	
Transporters: Whites			5				5	
Grand total	151		178		98		427	
PRODUCTS.								
Canned (½-pound cans)							a 6,357	40,395
Canned (1-pound cans)							a 95,448	811,366
Dry salted for food							b 510,000	20,150
Fresh for bait							b 1,254,926	11,210
Frozen for bait							b 2,444,655	24,246
Pickled for bait							b 40,000	800
Pickled for food, Scotch cure							b 7,718,985	451,240
Pickled for food, spiced							b 11,715	1,676
Pickled for food, Norwegian cure							b 2,216,120	147,634
Fertilizer							c 856	56,653
Oil							d 169,374	110,800
Total								1,676,170

a Cases. b Pounds. c Tons. d Gallons.

COD FISHERY.

The outstanding facts in connection with the cod industry of Alaska in 1919 are a decrease in production of 23 per cent as compared with that of 1918 and a reduction in the number of operators from 32 to 19. The most conspicuous withdrawal from this field was that of the Northern Fisheries (Inc.), which in 1918 was likewise the most conspicuous accession to the list of operators. Other withdrawals were said to have been occasioned by the lack of transportation, a difficulty which could not be overcome successfully, since no regular

steamer service was maintained in western Alaska. Other operators claimed that their business was injured by the importation of cod from Japan with which they were unable to compete.

Bering Sea retains its supremacy as the chief field of production, though very considerable catches were made on the banks of the Pacific Ocean south of the Alaska Peninsula. Winter fishing in the vicinity of the Shumagin and Sannak Islands is carried on rather indifferently since the introduction of power dories, previous to the use of which it constituted a prosperous industry. The reason assigned for the decline of the winter fishing is that the fishermen are not able to handle the additional weight which the installation of power in the dories has meant when it becomes necessary to launch or haul out their boats. The common dory was easily handled on the beaches.

VESSEL FISHERY.

Two important changes occur in the list of companies and individuals carrying on the vessel cod fishery of Alaska in 1919; one is the omission of the Northern Fisheries (Inc.), which did not resume operations after 1918, and the other the addition of Lars Mikkelson who purchased and sent north to engage in cod fishing in the vicinity of the Aleutian Islands the steamer *Dora*, which by reason of its years of faithful service to the people of western Alaska, is now the most noted vessel in Territorial waters. The small gas schooner *Alice*, used by the Northern Fisheries (Inc.), in connection with its shore station at Kodiak, is now shown under the name of the W. J. Erskine Co., while the schooners *Charles Brown* and *Azalea* and the gas schooner *Valdez* are dropped from the list. The *Allen A*, belonging to the Alaska Codfish Co., was reported a total loss by being blown ashore on Unga Island early in the year, but subsequently it was hauled off and towed to Seattle for repairs, and finally sold. The *Fanny Dutard*, owned by J. A. Matheson, was withdrawn from foreign trade in which it was engaged in 1918 and reentered the Bering Sea cod fleet in 1919. No other changes were noted in the vessels operated.

ALASKA COD FLEET IN 1919.

Name.	Rig.	Net tonnage.	Operators.
City of Papeete	Schooner	370	Alaska Codfish Co., San Francisco, Calif.
Glendale	do	281	Do.
Maweema	do	392	Do.
Alasco	Power schooner	23	Do.
Alasco II	do	5	Do.
Alasco III	do	8	Do.
Trio	do	9	Alaska Ocean Food Co., Seattle, Wash.
Fanny Dutard	Schooner	252	J. A. Matheson, Anacortes, Wash.
Dora	Steamer	217	Lars Mikkelsen, Seattle, Wash.
John A.	Schooner	235	Pacific Coast Codfish Co., Seattle, Wash.
Chas. R. Wilson	do	328	Do.
Maid of Orleans	do	171	Do.
Alice	do	220	Robinson Fisheries Co., Anacortes, Wash.
Wawona	do	413	Do.
Sequoia	do	324	Union Fish Co., San Francisco, Calif.
Galilee	do	328	Do.
Beulah	do	339	Do.
Louise	do	328	Do.
Martha	do	14	Do.
Golden State	Power schooner	223	Do.
Pirate	do	30	Do.
Union Flag	do	10	Do.
Alice	do	15	W. J. Erskine Co., Kodiak, Alaska.
Flossie	do	10	Do.
Edith	do	7	Do.

SHORE STATIONS.

Only two concerns in southeast Alaska reported having handled any cod. They were Libby, McNeill & Libby and the New England Fish Co., both of which froze a few tons of cod incidentally in the freezing of halibut. The more important operators in central Alaska were the Alaska Ocean Food Co., at Port Chatham; W. J. Erskine Co. and O. Kraft & Son, at Kodiak; Shumagin Packing Co., at Squaw Harbor; Pacific American Fisheries, at Ikatan; and the Union Fish Co. and the Alaska Codfish Co., at several stations in the Shumagin and Sannak Islands.

STATISTICAL SUMMARY.

The investment in the Alaska codfish industry in 1919 was $1,286,-075, which is an increase of $14,957 over that of 1918. A total of 702 persons were employed as compared with 697 in 1918.

A total of 10,893,312 pounds of cod was produced, having a value of $825,990. This is a decrease of 3,169,648 pounds in production, and $131,194 in value.

INVESTMENT, PERSONS ENGAGED, AND PRODUCTS OF ALASKA COD FISHERY IN 1919.

Item.	Quantity.	Value.	Item.	Quantity.	Value.
INVESTMENT.	*Number.*		PERSONS ENGAGED—contd.		
Value of shore stations		$139,070	Transporters:	*Number.*	
Cost of operations		196,590	White	173	
Wages paid		546,063			
Vessels:			Grand total	702	
Power vessels over 5 tons	10	114,644			
Net tonnage	547		PRODUCTS.		
Launches under 5 tons	50	26,915			
Sailing vessels	14	239,070	Vessel catch:	*Pounds.*	
Net tonnage	3,753		Dry salted cod	8,015,668	$638,880
Dories	292	14,590	Pickled cod	416,398	20,837
Pile drivers	2	250	Frozen cod	86,971	4,209
Apparatus:			Tongues	17,400	1,740
Seines (75 fathoms)	1	250			
Gill nets (75 fathoms)	1	195	Total	8,536,437	665,666
Hooks	3,024	53			
Lines	1,246	8,385	Shore-station catch:		
			Dry-salted cod	1,813,675	134,417
Total		1,286,075	Pickled cod	539,700	25,177
			Stockfish	2,900	700
PERSONS ENGAGED.			Tongues	600	30
Fishermen:			Total	2,356,875	160,324
Whites	494				
Natives	8		Total:		
Negroes	2		Dry-salted cod	9,829,343	773,297
			Pickled cod	956,098	46,014
Total	504		Frozen cod	86,971	4,209
			Stockfish	2,900	700
Shoresmen:			Tongues	18,000	1,770
White	25				
			Total	10,893,312	825,990

WHALE FISHERY.

SHORE STATIONS.

Three companies were reported as having engaged in whaling operations in Alaska in 1919. They were the United States Whaling Co., at Port Armstrong; North Pacific Sea Products Co., at Akutan; and the Pioneer Mining & Ditch Co., at Nome, the latter concern taking only the beluga or white whale.

The United States Whaling Co. operated three steamers in whale killing, *Star I* (133 tons), *Star II*, and *Star III* (97 tons each). The North Pacific Sea Products Co. employed a fleet of four steam whalers, the *Kodiak* and *Unimak* (99 tons each), the *Paterson* (77 tons), and the *Tanginak* (71 tons). The steamer *Elihu Thompson* (448 tons) and the barge *Fresno* (1,149 tons) were used as transporting and refrigerating vessels. No losses were reported in this industry. The results of the season were exceptionally gratifying, a large number of whales being captured.

STATISTICAL SUMMARY.

The investment in the whaling industry in Alaska in 1919 was $1,790,867, an increase of $439,896 over 1918. Employment was given to 311 men, or 14 less than in 1918. The value of the whale products was $1,027,200 as compared with $834,127 in 1918. Whales to the number of 580 were taken, exceeding the number taken in 1918 by 132.

INVESTMENT, PERSONS ENGAGED, AND PRODUCTS OF ALASKA SHORE WHALING OPERATIONS IN 1919.

Item.	Number.	Value.	Item.	Number.	Value.
INVESTMENT.			PRODUCTS.		
Vessels:			Whales:		
Steam and gas	8	$415,000	Finback	242	
Net tonnage	1,121		Humpback	132	
Barge	1	30,000	Sulphur-bottom	68	
Net tonnage	1,149		Sperm	95	
Launches under 5 tons	2	1,400	Sei	2	
Rowboats	2	60	Beluga	41	
Scows	2	400			
Pile driver	1	150	Total	580	
Value of plants		427,339			
Cash capital		633,139	Whale oil	[a] 875,374	$656,510
Wages paid		283,379	Sperm oil	[a] 377,032	276,344
			Fertilizer, meat	[b] 2,060,000	76,420
Total		1,790,867	Fertilizer, bone	[b] 538,000	13,472
			Whalebone	[b] 13,647	2,729
PERSONS ENGAGED.			Ivory, sperm	[b] 746	225
			Meat, frozen	[b] 50,000	1,500
Whites	226				
Natives	26		Total		1,027,200
Japanese	59				
Total	311				

[a] Gallons. [b] Pounds.

CLAM CANNING.

The only reported clam canning in Alaska in 1919 was carried on by three companies in the central district. Two of these, the Pioneer Packing Co., at Cordova, and the Pinnacle Rock Packing Co., at Boswell Bay, Hinchinbrook Island, continued operations in accordance with the custom of preceding seasons, obtaining their raw product from the beds between Hinchinbrook Island and the mainland from Cordova to Katalla. The Surf Packing Co., a new concern, opened a cannery at Tuxedni Harbor, on the west shore of Cook Inlet, and made a small pack. It operated in virgin territory where clams were said to be fairly abundant, but on this point there is no trustworthy information at hand and nothing is known of the size of areas occupied by the clams. As that company was also engaged in the canning of salmon, it is shown in that category and not listed as a clam cannery. It is also indicated elsewhere in this report that the Pioneer Packing Co. entered the salmon-canning business for which reason its classification was changed from the clam to the salmon industry, and the investments entered accordingly. This leaves the Pinnacle Rock Packing Co. as the only concern engaged exclusively in the canning of clams. The Lighthouse Canning Co., the pioneer clam-packing concern of central Alaska, sold its cannery at Cordova and ceased to operate. The Hillery-Scott Co., its successor, did not pack clams. Aside from the changes in the character of operations as noted above, the smaller pack in 1919 in comparison with that of the two seasons immediately preceding would presage a diminution in the supply of clams.

The investment in this industry in 1919 was $147,167. Employment was given to 237 persons, an increase of 55 over 1918. The total pack was 33,765 cases as against 43,575 in 1918. The products were valued at $184,363, as compared with $214,504 in 1918, a decrease of $30,141.

INVESTMENT, PERSONS ENGAGED, AND PRODUCTS OF ALASKA CLAM-CANNING INDUSTRY IN 1919.

Item.	Number.	Value.
INVESTMENT.		
Canneries operated	1	$22,000
Working capital		49,990
Wages paid		69,377
Vessels:		
Power dories	10	3,000
Rowboats and skiffs	36	1,800
Scows	1	1,000
Total		147,167
PERSONS ENGAGED.		
Diggers:		
Whites	185	
Natives	6	
Filipinos	1	
Total	192	
PERSONS ENGAGED—contd.		
Shoresmen:		
Whites	42	
Natives	3	
Total	45	
Grand total	237	
PRODUCTS.		
½-pound cans [a]	[b] 13,874	$55,496
No. 1 eastern oyster cans [a]	[b] 19,891	128,867
Total	33,765	184,363

[a] 48 per case. [b] Cases.

MINOR FISHERIES.

TROUT.

The most notable change in respect to the trout fisheries of Alaska in 1919 was the failure to operate of the Midnight Sun Packing Co., at Kotzebue, where 2,587 cases of Dolly Vardens were canned in 1918—the largest single product of the trout fisheries. The canning and pickling of trout almost ceased in 1919; only 371 cases, valued at $3,496, were packed, largely by four salmon-canning companies in central Alaska, and 11 barrels were salted in western Alaska. There was an increase in the quantity of fresh trout handled in southeast Alaska, the entire production being credited to the Ripley Fish Co. The gross value of all trout products in 1919 was $13,155, a decrease of $20,529 as compared with the output in 1919.

Products of Alaska Trout Fishery in 1919.

Section and species.	Fresh.		Frozen.		Pickled.		Canned.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Barrels.*	*Value.*	*Cases.*	*Value.*
Southeast Alaska:								
Dolly Varden	68,584	$8,282					3	$27
Steelhead	12,383	804	2,780	$408				
Total	80,967	9,086	2,780	408			3	27
Central Alaska:								
Dolly Varden							265	2,761
Steelhead							12	108
Total							277	2,869
Western Alaska:								
Dolly Varden					11	$165	91	600
Grand total	80,967	9,086	2,780	408	11	165	371	3,496

SABLEFISH.

None of the minor fisheries of Alaska shows a greater shrinkage in production than the sablefish. Whether it be due to a smaller catch or to the failure to save the entire catch can not be stated. As sablefish are taken in fishing for halibut and yield but a small return to the fishermen, it seems probable that a considerable quantity may have been wasted rather than that there was an actual shortage in the supply. The catch is made chiefly on the halibut banks off the coast of Alaska. The total production of sablefish was 509,369 pounds, valued at $35,485, a decrease of 826,670 pounds in quantity and $31,866 in value; 289,158 pounds, valued at $22,682, were shipped fresh, and 220,211 pounds, valued at $12,803, were shipped frozen.

RED ROCKFISH.

The red rockfish, like the sablefish and other deep-water fishes, are taken largely on the halibut banks in connection with that fishery. The demand for rockfish is somewhat limited, a fact which doubtless curtails deliveries to buyers. The total reported production in 1919 was 69,048 pounds, valued at $1,414, as compared with 338,669 pounds in 1918, valued at $67,351.

CRABS.

John Murphy, at Tenakee, was the only operator in Alaska reporting a catch of crabs in 1919. He marketed 80 dozen, valued at $160. His investment in the crab fishery was $200.

Inquiries made in 1919 regarding the methods of canning crabs indicate a desire on the part of some salmon packers to engage in the canning of crabs if the process is not too difficult and costly. This is a matter which merits investigation, as under proper encouragement a new industry may be developed in Alaska.

SHRIMPS.

Shrimp fishing in Alaska in 1919 was carried on by one operator, the Alaskan Glacier Sea Food Co., at Petersburg. Employment was given to 2 white fishermen and 15 Japanese shoresmen. The investment in plant, boat, gear, and wages paid was $41,796. The total production was 60,000 pounds of shrimp, valued at $21,000. Market conditions were unsatisfactory to the company operating in Alaska, as the competition originating in southern waters could not be met without serious loss.

MISCELLANEOUS FISHERY PRODUCTS.

Under this head are classed all flatfish, smelt, "lingcod", etc., which are taken in small quantities in connection with more important fishery operations. The total output was 52,123 pounds, valued at $1,639.

MINOR FUR-BEARING ANIMAL WORK.

GENERAL WORK.

The major functions of the Bureau in Alaska have been devoted primarily to affairs pertaining to the fur seals of the Pribilof Islands and the general fisheries operations in the coastal regions. To the extent that facilities and funds have permitted, attention has been devoted to the minor fur-bearing animals. In his annual report for the fiscal year ended June 30, 1919, the Commissioner of Fisheries again recommended that the Bureau be relieved of the incongruous duty of administering the minor fur-bearing animals of the Territory. Favorable action by Congress is anticipated in the near future, it being probable that jurisdiction will be transferred to the Bureau of Biological Survey of the Department of Agriculture.[a]

The arrangement made in 1918 with the governor of Alaska whereby employees of the Bureau have been named as ex officio game wardens and the Territorial game wardens and special employees for the suppression of the liquor traffic among the Indians have been designated as special wardens in the Bureau's Alaska service, without additional compensation, was continued in effect during the year 1919. Some changes in the force of wardens have occurred. The employees under direction of the governor's office identified with this work in 1919 were as follows:

Game wardens: Patrick Hamilton, Ketchikan; J. C. Lund, Juneau; P. S. Ericksen, McCarthy; J. A. Baughman, Seward; Stephen Foster, Nenana; R. E. Steel, Eagle; and M. O. Colberg, Nome.

Special employees: J. F. McDonald, Juneau; J. A. Bourke, Valdez; Thomas P. Killeen, Nome; and John A. Moe, Ruby.

P. S. Ericksen, of McCarthy, was succeeded by E. A. Young at Chitina.

In January, 1920, the services of Stephen Foster were discontinued.

The Bureau has continued the employment of Game Warden F. A. Martin at Anchorage as special fur warden at a nominal salary. The cooperative arrangement with the governor's office has been of value in that a number of violations of the fur-bearing animal law and regulations, which otherwise would probably have gone unnoticed, have received attention.

Reports have been received that more than the usual number of blue foxes have been taken along the Bering Sea coast between Cape Avinof and the Yukon delta. The death of so many natives in the Bristol Bay region as a result of the influenza epidemic has greatly reduced the number of persons trapping and will probably mean increased takes by the white trappers, though possibly not so large an output from the district as a whole.

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[a] The act of Congress approved May 31, 1920, transferred jurisdiction over the minor fur-bearing animals of Alaska to the Bureau of Biological Survey, Department of Agriculture.

REGULATIONS.

There was no change in the minor fur-bearing animal regulations in 1919, but under date of January 9, 1920, the following regulation was issued by the Secretary of Commerce, extending the prohibition on the killing of sea otters in Alaska:

> By virtue of the authority vested in me by section 4 of "An Act to protect the seal fisheries of Alaska, and for other purposes," approved April 21, 1910, it is hereby ordered that the killing of any sea otter within the limits of Alaska Territory or in the waters thereof is prohibited until November 1, 1925.

Years ago sea-otter hunting was a lucrative industry in North Pacific waters, and, as not infrequently happens, it was conducted so assiduously that the practical extinction of sea otters resulted. Protective legislation has undoubtedly had a beneficial effect, but the reestablishment of sea otters upon a commercial basis can not be expected for years to come. It is urgently necessary that every precaution be taken to protect fully this highly valuable marine fur-bearing animal. By the terms of the North Pacific Sealing Convention of July 7, 1911, the taking of sea otters in waters covered by it outside the 3-mile limit is prohibited. In administering the fur-bearing animal laws and regulations within the Territorial waters of Alaska, it is the policy of the Bureau to support and parallel the provisions of the international treaty in respect to sea otters.

The Bureau has from time to time received advices of a desire in certain parts of Alaska for the removal of the prohibitions upon the killing of beaver and marten. The Bureau feels, however, that the time is not yet ripe for making an open season for these valuable fur-bearing animals, as there is no authentic evidence available to show that their numbers have been replenished to an extent justifying such action. Undoubtedly both beavers and martens are more numerous in some sections of Alaska than a few years ago, but this is the best evidence that the regulations were needed and have been producing beneficial results. A continuance of the same policy for some time to come is considered advisable.

VIOLATIONS OF REGULATIONS AND SEIZURES OF SKINS.

On January 22, 1919, Assistant Agent Christoffers cooperated with the collector of customs at Seattle in the seizure from an express company of 10 trunks containing skins consigned from Seward, Alaska, to San Francisco. The trunks were the property of J. H. Smith, of Anchorage, and contained 717 beaver skins, 20 swan skins, and one can of beaver castors. No claim was made for possession of the furs, and the shipper was not apprehended for prosecution.

On February 1, 1919, Special Warden Martin seized 44 marten skins from John E. Carlson at Anchorage. Carlson was fined $100 and costs, amounting in all to $118.15.

Game Warden Stephen Foster seized two marten skins, one on February 17, 1919, from Charles P. Christiansen and one on March 4, 1919, from Tom Cook, both in the Kantishna River region.

United States Commissioner Charles J. Koen, of St. Michael, forwarded to the Seattle office three beaver skins which were seized from two natives, one of whom pleaded guilty and was sentenced to 20 days in jail, while the other stood trial, was convicted, and sentenced to 60 days in jail. Commissioner Koen also reported that in April

and May he sentenced five other natives to terms in jail ranging from 10 to 30 days for the killing of beaver. The skins were not secured. All of these cases originated on the Galsovia River.

In May, 1919, Game Warden Lucy seized a beaver skin from a native named Jim Johnny Mie in the vicinity of Petersburg. Mie was prosecuted for having the skin in his possession, pleaded guilty, and served five days in jail at Ketchikan.

In June, 1919, Warden Larson seized a beaver skin from an Indian near Ketchumstock.

One June 22, 1919, Frank O'Farrell shipped 13 marten skins from Tanana, which were seized by Deputy Collector of Customs Hillard at Eagle and turned over to Game Warden R. E. Steel. Twelve more marten skins were seized by Warden O'Connor at Skagway on July 7 when a parcel-post package addressed from Tanana to O'Farrell at Seattle was examined under search warrant. All the skins were forwarded to the Seattle office of the Bureau. O'Farrell afterward presented a certificate, dated June 26, 1919, that 25 marten skins were of Canadian origin. The Bureau, upon the recommendation of the deputy collector of customs at Eagle, refused to accept it as covering the seized skins, and they were confiscated.

Examination of mail shipments were made at Skagway under search warrants by Warden Philip R. Hough on July 16 and 17 and resulted in the seizure of 20 marten shipped by R. L. Smith from Ruby, 25 beaver shipped by D. R. Stern from Nulato, and 1 beaver by John B. Steppe from the Kantishna region. The skins were retained by the marshal at Skagway until released to the Bureau by a court order in March, 1920, and were then forwarded to Seattle.

In July, 1919, certain seizures of illegally taken furs were made in Alaska by the United States marshal, these furs having been placed in the mail by Peter Vachon of Tolovana. The shipments were located by means of search warrants executed with the permission of the Post Office Department at the post office at Tolovana and on board a vessel near Eagle. The seizures comprised 714 marten skins and 699 beaver skins, which at the end of the year were still in the possession of the United States marshal at Fairbanks for use in the prosecution of the shipper.

On August 9 customs officials at Seattle seized seven beaver skins from James P. Browner, chief engineer of the schooner *Ozmo*. Browner stated that the skins had been given to him by J. W. Felder in the Kuskokwim district, and that he did not know that their possession was unlawful. No prosecution was instituted; the skins were turned over to Assistant Agent Christoffers.

On September 5 the deputy collector of customs at St. Michael seized from a man named Miller 88 beaver skins turned over to him by Chris Betsch, a trader, to deliver to a bank at Nome. Other prosecutions were made as follows: Joe Knox, 7 beaver skins seized, sentenced to 30 days in jail; Sam Tajari, 24 beaver skins seized, fined $200 and costs; Chris Betsch, 170 beaver skins seized, fined $200 and costs. The case against Miller, in whose possession the 88 skins were found, was dismissed as it had been shown that the skins were turned over to him by Betsch for delivery to the Merchants and Miners Bank of Nome. The 289 skins were forwarded to the Bureau's Seattle office in June, 1920, by the United States marshal for sale for the account of the Government.

On October 17, 1919, Assistant Agent Christoffers, assisted by five deputy customs officers, searched the schooner *Ozmo*, arriving from the Kuskokwim River region, and seized 41 beaver and 4 swan skins.

On November 26, 1919, Warden O'Conner seized two marten skins from a native named Peter Brown. Prosecution was instituted in the United States commissioner's court at Haines against Brown for having illegally taken skins in his possession. He was tried on December 29 and was fined $25 and costs.

On November 30, 1919, Warden O'Connor seized 69 muskrat skins at Haines from Harry Lindberg, a fur buyer. Lindberg was arraigned before the United States commissioner for having unprime skins in his possession, but the case against him was dismissed with the understanding that he would testify in behalf of the Government against Tom Lahey from whom he had purchased the skins. Lahey was charged with trapping muskrats in the close season, but at the trial in the United States commissioner's court at Juneau on December 13, 1919, the jury returned a verdict of not guilty. The court returned the skins.

On December 21, 1919, N. A. T. Joe was convicted before the United States commissioner at St. Michael of killing a mink on October 4, 1919. He was sentenced to 60 days in jail.

During the year two fur-seal skins, which had not been properly authenticated, were received by Funsten Bros. & Co. Both had apparently been taken by fishermen, one being sent in by John Michelson of Sointula, British Columbia, and the other by Charles Landberg of Neah Bay, Wash. They were accordingly confiscated by the Government and will be sold by the company at public auction.

SALES OF SEIZED SKINS.

During the calendar year 1919, the following seized skins were sold at public auction: In St. Louis, 8 fur-seal skins; and in Seattle, 753 beaver, 92 marten, 54 mink, 7 weasel, 3 lynx, 32 muskrat, 1 cross-fox, 20 swan skins, and 42 pounds of beaver castors. The gross amount received was $16,236.27. Commission and other expenses amounted to $866.75, leaving a balance of $15,369.52 turned into the United States Treasury. A few seized skins remained unsold at the end of the year.

FUR FARMING.

Fur farming in Alaska is largely concerned with the propagation of foxes, though occasionally attempts are made to raise in captivity minks and martens, but without success. Foxes lend themselves more easily to domestication, especially the blue variety, and are exceptionally prolific under favorable conditions. Their skins have a comparatively high value at this time, which fact, coupled with that of easy breeding, constitutes sufficient inducement to the venturesome to engage in the industry, notwithstanding that the business is attended with risks and discouraging vicissitudes.

As in other undertakings, some failures were caused by careless and indifferent attention to business; others were due to the selection of

islands much too small for the purposes intended or too near other land, and to improper or inadequate feeding or none at all.

Fox farming follows two methods, impounding or corral breeding, and free-range or island breeding. Under the corral method, propagation has proved decidedly unsuccessful in most cases, not so much in actual breeding but in the rearing of young and the preservation of parent stock. Confinement in pens, necessarily of very limited dimensions, has two noticeable effects on foxes. Being accustomed to freedom in their movements, its denial either makes them vicious or morose. In the one case, they become fighters, destroying their young, their mates, and companions of the same sex; in the other, their time, night and day, is spent in a continual search for a way of escape, which if not found increases their misery and is often not ended until death supervenes.

Island breeding has been very successful when seriously undertaken. A prime requisite is area great enough to afford considerable range to the foxes and sufficiently distant from other land to prevent their escape. An ample supply of food is also necessary, for underfed foxes become cannibalistic, or puny and weak, if not diseased. If the natural food to be found on the island is not sufficiently abundant to properly sustain the animals, the deficiency must be supplied by the efforts of the fur farmer. His energy in this direction will probably determine the degree of success or failure which will attend his labors. Foxes at liberty on suitable islands will take care of themselves just as long as food is ample and they are not crowded. In the end intelligent management is indispensable to successful results.

From time to time the Bureau receives information from the fox farmers in Alaska regarding their experiences and success or failure, much of which may be of general interest and benefit to all fur farmers. Among those who operated in 1919 and filed reports are the following:

Sholin Bros. & Co., of Homer, report encouraging results in the rearing of silver-black foxes in corrals. At the beginning of 1919 they had 12 pairs of breeders, 9 of which produced young, the litters varying from 2 to 5 pups each. The total increase was 28, all of which were successfully raised. Fifteen pairs are being held for breeders in 1920. The foxes are fed fish, birds, porcupines, hair seals, and cereals, but chiefly fish which is mixed with a cereal and boiled to a porridge and fed at evening. The morning meal consists of bread made of shorts and a little seal oil. Occasionally meat is fed. These operators have found that the foxes do better in pens built 6 feet apart than in those connecting or immediately adjoining each other.

F. Berry, 12 miles northeast of Homer, is also breeding foxes in corrals. He started business in 1918 in partnership with Dr. E. F. German, of Anchorage, with one pair of silver-black foxes. A litter of pups was produced in 1919, but nothing was saved from it, as the parent male fox destroyed the young. Mr. Berry gives directions for the prevention of worms and internal parasites in foxes, as follows:

> Burn all your old bones, pound them—not too fine—and add equal quantities of clean charcoal (burnt in the kitchen stove) of some hardwood; now chop fresh meat—something they like very well—and roll it and rub it into the charcoal and pulverized bone until it loses all semblance to meat in the mixture, then feed. They will not mind the dirt, just so they get the meat. One feed a week like this and your animals will never know worms.

In the fall of 1918, Abraham Ericksson, at Kenai, purchased two pairs of silver foxes at a cost of $1,700 and placed them in pens. During the year both males killed their mates. In October he traded one male for a female, thus giving him a pair for breeding in 1920.

Joseph Falardeau, operating a fox farm at the head of Kachemak Bay, reports encouraging results in 1919. At the beginning of the year he had on hand five male and seven female silver foxes. Three pairs of these produced a total of nine pups, five being males and four females. This enabled him to increase his breeding stock to nine pairs. Mr. Falardeau regards it as important that each farmer endeavor to raise farm produce, also other products which may be required for fox food, to supplement the natural food resources of the region, such as fish, rabbits, and birds. Milk and eggs are especially desirable as food for young foxes.

Andrew Siewertson, who is using Perry Island as a fox farm, reports that out of a breeding stock of 12 blue foxes he lost 4 families by theft or desertion, raised 36 young, killed 2 for their skins, and sold 12 pairs.

J. D. Jefferson has stocked Bald Head Chris Island with blue foxes and the Dutch Group with cross foxes, having entered upon both in the spring of 1917. The increase of blues is not definitely known by Mr. Jefferson, but he estimates that there are now from 20 to 25 foxes on the island. One male and two female cross foxes, placed on the Dutch Group in 1917, have done nothing. They were taken off this year. The islands will be stocked with blue foxes under the ownership and management of C. L. Hoyt, who is fox farming on Axel Lind Island, a few miles from the Dutch Group.

Lee E. Dickinson operates a fox farm on Flemming Island in the western part of Prince William Sound, having stocked it in 1919 with dark-blue foxes. He reports that the foxes are fed fresh fish, chiefly cod and halibut, and that they thrive on that diet. This is in striking contrast with the statement of Mr. Jefferson, who reported that his foxes did not like cod and would not eat it ordinarily unless cooked and mixed with other things.

Passage Island, situated in the entrance of Port Graham, is used as a blue-fox farm by J. A. Herbert, of Seldovia. This farm was established several years ago and has been fairly successful. At the beginning of 1919 the stock consisted of 25 pairs. These produced about 100 pups, but heavy losses occurred, as approximately 80 per cent of the young were killed and carried away by eagles. Only 23 pups reached maturity. Twenty-seven foxes were sold for breeding purposes, 25 were killed for their pelts, and 10 pairs were held as stock for 1920. Salted fish heads were used as food for the animals. These are easily obtained at the cannery of the Fidalgo Island Packing Co. at Port Graham.

Hesketh and Yukon Islands, in Kachemak Bay, are used for fox-breeding purposes by U. S. Ritchie, who began this work more than 20 years ago. His foxes run at large, and can pass from one island to the other at low water. A few were killed for their skins, while 10 pairs were obtained elsewhere with which to restock, as the old stock was degenerating from inbreeding.

D. F. Dunagan, H. H. Waller, and J. L. Waller took over the fox corrals of N. P. Shular at Anchor Point and will continue operations under the name of the Anchor Point Silver Fox Farm. When owned

by Mr. Shular, this farm was reputed to be the most successful one in Alaska handling black and silver foxes.

O. Kraft & Son discontinued their fox-raising business on two small islands in Kalsin Bay, Kodiak Island, and removed all animals therefrom in the winter of 1918–19. The islands were much too small and were surrounded by reefs, to which the foxes would go at low water and not return before the flood tide cut them off from the island. When forced to swim, some of them left for the mainland of Kodiak and thus escaped.

Alex Friedolin continued operations on Hog Island, which he had stocked with blue foxes. No young animals were seen in 1919, and Mr. Friedolin thinks that the introduction of two strange males disturbed the other foxes and possibly caused the young to be killed. But one pelt was taken. Three pairs of breeders have been retained.

In May, 1919, Lars Hansen placed four pairs of blue foxes on Chankliut Island, near the entrance to Chignik, where he had the year before planted mice to supply food for the foxes. One litter of young was born in 1919, but as the foxes run at large he does not know how many there were.

A. F. Piper, of Seldovia, reports that he has started a skunk farm with eight animals which were shipped from the States.

Peter Petrovsky continued operations on Amook Island. Part of his foxes are kept in corrals and others run at large on the island. No young foxes were raised in the corrals in 1919. In all, 16 foxes were killed for their pelts.

Rufus D. Blakely, of Ketchikan, reported further on his fur-farming operations on Bold Island. Beavers have been established in the lake in addition to the muskrats and appear to find a plentiful supply of food. Plans for stocking the island with foxes and marten are in abeyance.

Harry D. Colp reported that he has established a fur farm on Kupreanof Island near Petersburg. He has five pairs of silver foxes in corrals, one of which raised three pups in the spring of 1919. A varied diet is given the foxes, consisting of fish, several kinds of meats, rice, dog biscuits, and green stuff. Mr. Colp states that he does not expect to market any furs for some time as he wishes to increase his stock. He considers the possibilities of the business good.

C. E. Zimmerman is using the Brothers Islands in southeast Alaska for the propagation of raccoons and skunks. These islands were similarly used about six years ago, and it is Mr. Zimmerman's belief that some of the original stock still remains. He placed additional animals on the islands in the fall of 1919.

A. C. Smith, of Haines, reports that he has five silver-gray and one cross fox. No pups were born in 1919. One pair of silvers died as the result of fighting.

Aug. Wenzel continued operations on a ranch 32 miles below Fairbanks on the Tanana River. He reports having seven pairs of silvers and three pairs of crosses. But one pup was produced and raised this year. A total of three silver, four red, and four cross pelts were sold in the spring of 1919. Mr. Wenzel says that his foxes are tame and healthy. The food given is principally fish, cooked in summer and dried in winter. The rabbits are said to be coming back, and will thus furnish needed fresh meat.

W. H. Newton, of Healy River, reported that there was no increase in 1919 from his stock of four pairs of foxes; this possibly

was due to disturbance incident to clearing off timber near their quarters. Four of the animals were killed to cover expenses and two pairs were retained for stock. He feeds fish and vegetables with the addition of fat scraps.

L. G. Michael reports excellent results at his ranch near Franklin. At the beginning of 1919 he had 7 pairs of breeders, 2 silver and 5 cross males, and 4 red and 3 cross females; 17 pups were born, of which all but 1 were raised. He is retaining a stock of nine pairs of breeders. Mr. Michael writes that he feeds the young foxes plenty of canned milk, diluted 1 part milk and 2 parts water, with a little sugar added, about a tablespoonful to a quart. The adult foxes are fed fresh meat almost entirely. Although the foxes are all large animals they are confined in corrals. Mr. Michael says that the future for fox farming has never looked better.

A number of fur farmers mention the great number of gulls and other sea birds, and object to the prohibition against killing such birds for food for their animals.

LEASING OF ISLANDS.

The Department of Commerce has jurisdiction over 12 islands in central Alaska which are leasable, or have been leased to the highest bidder. These islands and their locations are as follows:

Chirikof	Southwest of Kodiak Island.
Long	Near Kodiak Island.
Marmot	East of Afognak Island.
Little Koniuji	Shumagin Group.
Simeonof	Do.
Little Naked	One of Naked Islands, Prince William Sound.
Carlson (Crafton)	Prince William Sound.
Middleton	Gulf of Alaska.
Pearl	One of Chugach Islands.
Elizabeth	Do.
Aghiyuk	One of Semidi Islands.
Chowiet	Do.

Pearl Island was leased to I. D. Nordyke in 1917, but the annual rental has not been paid since that year. The lease has therefore been forfeited and the island is again available for lease to the highest bidder.

The islands named below were under lease on December 31, 1919:

Island.	Lessee.	Annual rental.
Chirikof	Karl Armstrong Kodiak, Alaska	$200
Long	Kodiak Fox farm, Kodiak, Alaska	200
Marmot	C. W. Pajoman and N. I. Greive, Afognak, Alaska	200
Little Koniuji	Andrew Grosvold, Sand Point, Alaska	205
Middleton	Joseph Ibach, Cordova, Alaska	200

Chirikof Island, southwest of Kodiak Island.—This island was leased on July 1, 1919, to Karl Armstrong, of Kodiak. It had previously been used by the Semidi Propagating Co., but was abandoned a few years ago. Mr. Armstrong reported that on taking possession of the island there were found signs of a number of foxes and for that reason he will put no new stock on the island until after the present trapping season, when he will be able to judge what is needed for the future.

Long Island, near Kodiak.—On July 1, 1919, a lease for this island was issued to the Kodiak Fox Farm. This concern had been using the island for several years under a misapprehension that it had a valid right thereto through purchase from a former occupant, who was found upon investigation to have had no title to the island and could, therefore, convey none. This farm is probably the most completely equipped of any in Alaska. Extensive extracts from a previous report were published in "Alaska Fisheries and Fur Industries in 1915," and it is thought that the following from the recent report of the company will be of interest:

As previously reported, we had a number of blue foxes in captivity. Subsequently these were all liberated, for after two seasons of effort not a single blue pup had been born in the pens. Although we tried many experiments, our efforts were unavailing and we gave up our attempt to raise blue foxes in captivity.

Since the blue foxes have been at large, however, the increase has been highly satisfactory and the quality of the fur has improved. We attribute this to the careful selection we have made during each trapping season and to the fact that our foxes have been bountifully fed.

We still continue to feed salmon heads, as this has proved the most satisfactory for blue foxes. During the salmon season only fresh heads are fed; but at the same time we pack about 400 barrels in salt (about 80,000 pounds) to be used for winter feeding. These are thoroughly freshened for about six days in running water before being given to the foxes.

The foxes have segregated themselves in colonies about the island, and in the vicinity of each colony a feeding box has been placed. Twenty-two of these are now used where food is distributed every other day.

Breeding records, as originally planned, can not, of course, be kept for the blue foxes at large on the island, but by careful selection during the trapping season of only the desirable animals to be left as stock the quality of the fur can no doubt be greatly improved. We trap only in box traps; the foxes are carefully examined, and if desirable for breeding stock they are marked by "bobbing" the tail and again liberated. It is our aim to liberate three females to two males of the best animals trapped.

During the trapping season of 1919, 33 blue-fox skins were taken, and it was estimated that 150 animals were left.

Our efforts in raising silver-gray foxes in captivity have not been successful. While we have raised a number of these, and have several now in the pens of the third and fourth generation, the percentage of increase has been so small that we have decided it would not pay us to continue, so we will kill off the remaining stock and devote our efforts to the blues. Furthermore, the wire netting of our pens is commencing to rust after five years, and unless this is renewed in a short time there will be danger of the silver grays getting loose on the island and killing off the blues. At present prices the cost of renewing this wire would be about $6,000 and we do not feel that our experience justifies such an expenditure.

During the winter of 1918–19 we killed 9 silver-gray foxes, leaving 21 silvers and 1 cross for breeding purposes. Shortly after this 11 of the silvers died, evidently from some epidemic among them, although we have been unable to determine the cause. Consequently, this season, we have not had a single pup from the silvers.

Two years previous we had a similar experience, having lost 10 of our breeders after the killing season from apparently the same disease. But this loss was more than replaced by 17 pups born and all successfully raised to maturity.

The 10 silvers and 1 cross will be killed this coming winter. We intend, also, to take about 50 blues, leaving about 100 on the island for stock.

Marmot Island, east of Afognak.—On July 1, 1919, a lease for this island was issued to Charles W. Pajoman and N. I. Greive, of Afognak. In October they placed thereon four cross and nine silver foxes. At the time of the lease the island was supposed to be barren.

Little Koniuji, Shumagin Group.—Andrew Grosvold continues as the lessee of this island. In November, 1919, the stock was increased by the addition of 19 pairs of blue foxes. In the year ending November 15, 1919, Mr. Grosvold took 30 skins. A year later he estimated that there were 30 pairs on the island.

Middleton Island, Gulf of Alaska.—This island is under lease to Joseph Ibach, of Cordova. The number of skins taken in 1919 has not been reported, but it is understood that results were satisfactory.

FOREST SERVICE PERMITS.

Every island in Prince William Sound at all suitable for a fox farm is now being used for that purpose. All of them, except Little Naked Island and Crafton (Carlson) Island, are under the control of the Forest Service by reason of their location within the bounds of a national forest. A number of islands in southeast Alaska within the Tongass National Forest are also occupied as fox farms. An annual rental is charged and each operator is required to make a report to the Forest Service as to the character and volume of business carried on during the year. Records in the offices of the Forest Service at Cordova and Ketchikan show information in respect to the use of the several islands as follows:

ISLANDS OCCUPIED FOR FUR FARMS UNDER FOREST SERVICE PERMITS.

Date of permit.	Island.	Occupant.
Aug. 1, 1913	Lone	F. A. Shumaker, Latouche, Alaska.
Jan. 1, 1919	Eleanor	Do.
Jan. 10, 1913	Perry	Andrew Siewertsen, Latouche, Alaska.
Aug. 5, 1915	Axel Lind	John Stainer, Ellamar, Alaska.
Applied for	Glacier	Otto Hermsdorf, Latouche, Alaska.
Aug. 3, 1919	Bettles	H. D. Bush, Granite, Alaska.
Aug. 11, 1919	Observation	Robert E. Towsley, Seattle, Wash.
June 16, 1919	Seal	John Agamalian, Latouche, Alaska.
Jan. 1, 1918	Fairmount	Beyer & Davis, Cordova, Alaska.
Jan. 1, 1919	Bligh and Busby	Cloudman estate, Tom Cloudman, Valdez, Alaska.
Mar. 20, 1916	Smith	G. W. Fleming, Latouche, Alaska.
Mar. 13, 1919	Flemming	Gordon & Harris, Cordova, Alaska.
Jan. 1, 1914	Green	T. A. Haxby, Latouche, Alaska.[a]
June 14, 1919	Kanak	Joseph L. Hill, Katalla, Alaska.
July 20, 1916	Bald Head Chris	J. D. Jefferson, Valdez, Alaska.
Dec. 26, 1916	Dutch Group	Do.
May 24, 1919	Elrington	Kulper & Baker, Latouche, Alaska.
Apr. 21, 1917	Goose	Arthur Laviosa, Ellamar, Alaska.
Jan. 1, 1912	Naked and Peak	J. A. McPherson, Ellamar, Alaska.
Oct. 9, 1917	Olson and 3 unnamed	Ross & Hoyt, Valdez, Alaska.
Oct. 23, 1919	Entrance	R. M. Allen, Petersburg, Alaska.
Oct. 14, 1919	Walter	Andy Anderson, Petersburg, Alaska.
July 1, 1919	Hound	Blue Bell Ranch.
May 31, 1916	Bold	Bold Island Fur Farm Co., Ketchikan, Alaska.
Nov. 21, 1917	Strait	Cleary Bros., Petersburg, Alaska.
Dec. 15, 1919	Benjamin	H. S. Graves.
Jan. 25, 1917	Sukoi	Hercules Fox Co., Petersburg, Alaska.
Sept. 9, 1919	Hoonah	Hoonah Fox Co., Hoonah, Alaska.
Aug. 28, 1919	Hill	L. B. McCoy, Chichagof, Alaska.
Dec. 11, 1919	Keku	V. A. Paine, Juneau, Alaska.
Nov. 26, 1917	Onslow	L. A. Stockley, 527 39th Ave., San Francisco, Calif.
Nov. 17, 1919	Liesnoi	Eric Todal, Petersburg, Alaska.
June 1, 1919	Sokolof	Wikan Bros. & Co.
June 29, 1914	Sumdum	James York, c/o E. Valentine, Juneau, Alaska.
Sept. 13, 1918	Brothers	C. E. Zimmerman, Petersburg, Alaska.

[a] Four Japanese have subleased this island from Dr. Haxby.

At the present time a number of fur farmers are occupying islands which are outside of the forest reserves, and serious complaint is made in regard to the difficulty of securing any valid claim on the land which they are using for their operations. Apparently the only way to secure protection through the General Land Office from trespassers is to homestead the land. Some provision for leasing these islands, or granting certain rights to bona fide occupants who are doing valuable development work, would seem to be desirable to assure the future of the business. Many islands along the coast of Alaska are suitable for fox farms. Those outside of forest reserves are open to occupancy in like manner as any other public land.

SHIPMENTS OF FURS FROM ALASKA.

As in previous seasons, shipments of furs from Alaska were reported on special blanks prepared by the Bureau. Supplies of blanks were furnished to all postmasters in Alaska and to commercial companies, express companies, and all persons known to be shippers of furs. Postmasters indorsed the reports of mail shipments after they were properly filled out and forwarded them to the Bureau.

Reported shipments in 1919 confirm the general belief that the fur-bearing animals in Alaska are decreasing in numbers. In spite of the continued high prices of furs, there was an increased catch of only a few species, the chief of which were ermine, mink, and muskrat. The most notable declines were in the catch of foxes and lynx. As in previous reports, the fur year is reckoned from November 16 of one year to November 15 of the following year.

The following table shows the detailed statistics as compiled from information furnished the Bureau in regard to furs shipped from Alaska in 1917, 1918, and 1919:

FURS SHIPPED FROM ALASKA IN 1917, 1918, AND 1919.

Species.	Year ended Nov. 15, 1917.			Year ended Nov. 15, 1918.			Year ended Nov. 15, 1919.		
	Number of pelts.	Average value.	Total value.	Number of pelts.	Average value.	Total value.	Number of pelts.	Average value.	Total value.
Bear:									
Black	1,061	$14.00	$14,854.00	1,164	$15.00	$17,460.00	1,388	$16.00	$22,208.00
Brown	62	12.00	744.00	35	12.00	420.00	44	12.00	528.00
Glacier	8	20.00	160.00	35	30.00	1,050.00	20	30.00	600.00
Grizzly	13	17.00	221.00	42	20.00	840.00	76	20.00	1,520.00
Polar	[a] 144	40.00	5,760.00	......	......	......	......	......	......
Beaver	[b] 118	10.00	1,180.00	[c] 109	21.00	2,289.00	[c] 796	17.76	14,139.96
Ermine	4,639	.90	4,175.10	9,133	1.50	13,699.50	18,617	1.90	35,372.30
Fox:									
Black	10	160.00	1,600.00	6	150.00	900.00	13	150.00	1,950.00
Blue	887	58.00	51,446.00	740	85.00	62,900.00	566	130.00	73,580.00
Blue, Pribilof Islands	567	61.11	34,653.50	692	82.51	57,099.50	667	195.31	130,274.50
Cross	2,669	35.00	93,415.00	1,704	50.00	85,200.00	1,280	70.00	89,600.00
Red	10,485	24.00	251,640.00	12,232	28.00	342,496.00	7,723	35.00	270,305.00
Silver gray	443	120.00	53,160.00	440	140.00	61,600.00	315	170.00	53,550.00
White	3,682	28.00	103,096.00	4,531	40.00	181,240.00	4,575	46.00	210,450.00
White, Pribilof Islands	39	26.33	1,027.00	19	56.84	1,080.00	30	55.33	1,660.00
Hare, arctic	89	.40	35.60	38	.10	3.80	135	.20	27.00
Lynx	21,210	14.00	296,940.00	7,692	26.00	199,992.00	1,085	42.00	45,570.00
Marten	[d] 1,210	14.00	16,940.00	[d] 1,023	19.00	19,437.00	[e] 1,107	32.00	35,424.00
Mink	18,832	4.00	75,328.00	24,572	6.50	159,718.00	28,040	9.00	252,360.00
Muskrat	72,264	.45	32,518.80	86,624	1.20	103,948.80	113,652	1.90	215,938.80
Otter:									
Land	1,308	15.00	19,620.00	1,647	22.00	36,234.00	1,709	25.00	42,725.00
Sea	[f] 2	344.85	689.70	[g] 1	150.00	150.00	[g] 1	300.00	300.00
Seal, fur, Pribilof Islands [h]	9,140	30.00	274,200.00	30,819	30.00	924,570.00	30,198	50.00	1,509,900.00
Seal, fur	[i] 5	30.00	150.00	[j] 9	30.00	270.00	......	......	......
Squirrel	117	.05	5.85	153	.02	3.06	2,120	.03	63.60
Wolf	195	8.00	1,560.00	207	18.00	3,726.00	284	19.00	5,396.00
Wolverine	435	8.00	3,480.00	846	14.00	11,844.00	516	15.00	7,740.00
Total	......	......	1,338,599.55	......	......	2,288,170.66	......	......	3,021,182.16

[a] The killing of polar bears in Alaska is unlawful.
[b] A considerable number were seized skins. It is unlawful to kill beavers in Alaska.
[c] Seized skins. It is unlawful to kill beavers in Alaska.
[d] Checked against affidavits permitting shipments. It is unlawful to kill martens in Alaska.
[e] Includes 93 seized skins. It is unlawful to kill martens in Alaska.
[f] Unlawfully killed by natives.
[g] Found dead.
[h] Figures are for shipments during calendar year rather than killings.
[i] Taken by natives.
[j] Seized skins.

FUR-SEAL INDUSTRY.

PRIBILOF ISLANDS.

GENERAL ADMINISTRATIVE WORK.

Commercial sealing operations were continued in 1919 on a scale commensurate with the size of the seal herd and the facilities available. The policy, inaugurated this year, of improving the seal herd and at the same time adding to the Government's revenue by killing considerable numbers of the surplus large males taxed the working force to the utmost. Careful attention was given to the herds of blue foxes, and the value of the pelts secured is ample evidence that appropriate methods are being pursued. The welfare of the natives was given conscientious attention, and it is felt that they are now living under much better conditions as a whole than ever before. The by-products plant was operated for a limited period with results which warrant operations on a larger scale in 1920.

Aside from the major features of the Bureau's work on the Pribilofs, numerous other matters in connection therewith received attention. Among these may be mentioned the annual seal census, maintenance and upkeep of Government property, and a special investigation devoted to improving sealing methods, particularly the curing of pelts. Details are set forth in the following pages.

PERSONNEL.

A list of the Bureau's statutory employees for the Pribilofs is given in the introduction to this report. Details in regard to their activities are, for purposes of record, stated below. The work of a number of temporary employees is also recorded.

Agent and Caretaker H. C. Fassett tendered his resignation early in the year and left St. Paul Island on the *Saturn* May 21. Agent and Caretaker A. H. Proctor proceeded from St. George Island to St. Paul Island on the *Saturn* May 6 to assume charge of the Bureau's work at St. Paul. Storekeeper H. D. Aller was on St. George Island until July 11, when he went aboard the Coast Guard cutter *Unalga* for St. Paul Island. He arrived there July 12, and left for Seattle on the Coast Guard cutter *Bear* October 20. From May 6 until July 10 he was in charge of the Bureau's work on St. George. School-teacher C. E. Crompton then assumed charge and was appointed agent and caretaker, effective August 16.

Storekeeper Dr. G. Dallas Hanna arrived at the Pribilofs on the *Saturn* May 5 and left on the *Nanshan* October 13. While on the islands he had charge of the seal census work. Dr. Charles E. Johnson was in charge of the medical work on St. George Island until relieved by his successor, Dr. W. M. Murphy, who arrived on the *Nanshan* in September. Later Dr. Johnson proceeded to St. Paul Island on the *Nanshan*, for temporary duty, where he remained until after the arrival of Dr. J. J. Richstein. Dr. Johnson left St. Paul Island for

Unalaska on the *Eider* November 25. Subsequently he proceeded to Seattle on a commercial steamer. Dr. J. J. Richstein left Seattle October 26 on the *Eider* and arrived at St. Paul Island November 23. Dr. H. H. Stromberger was on St. Paul until October 13, when, having tendered his resignation, he took passage on the *Nanshan* for Seattle. Mrs. Agnes K. Stromberger, who had been employed as a nurse at St. Paul, left at the same time. Dr. Frank H. Gunn arrived at St. Paul Island on the *Nanshan* in September and left the following month on the *Nanshan*. Mrs. Cora Giles Haley, school-teacher, tendered her resignation and left St. Paul Island on the *Nanshan* in October. Mrs. Lois Lippet Proctor was employed as teacher in the junior school on St. George Island for a number of months in the first part of the year and, effective October 1, was appointed school-teacher for St. Paul Island in place of Mrs. Haley. Edward C. Johnston, who had held a number of positions in the Bureau, including that of naturalist on the *Albatross*, prior to military service, was appointed school-teacher, effective August 16, and arrived at St. George Island on the *Nanshan* September 6 to take up his work. Mrs. Ella J. Johnston was appointed special school-teacher for St. George Island, effective September 15.

Mr. Wm. P. Zschorna, employed temporarily for certain technical investigations, arrived at the Pribilofs on the *Saturn* in May and left on the *Nanshan* in October. Mr. A. Christoffersen, by-products expert, also arrived at the Pribilofs on the *Saturn* in May and left on the *Nanshan* in October.

PURCHASE AND TRANSPORTATION OF SUPPLIES.

The regular supplies for the support of the natives and for the general operation of the Bureau's business at the Pribilofs were purchased through competitive bids, chiefly at Seattle, Wash. Following the practice of previous years, schedules covering the greater part of these supplies were printed and distributed in the spring to prospective bidders.

About 100 tons of salt and 15 tons of general supplies were forwarded from San Francisco April 16 on the U. S. S. *Saturn*, Naval radio vessel, which arrived at the Pribilofs (St. George Island) May 5. The bulk of the season's shipment was subsequently assembled at Seattle and forwarded on the U. S. S. *Nanshan*, a supply vessel made available by courtesy of the Navy Department. The *Nanshan* sailed from Seattle August 22 and arrived at the Pribilofs (St. George Island) September 6, 1920. The supplies forwarded consisted of approximately 1,300 tons of general freight and 45,000 feet of lumber for St. Paul and about 400 tons of general cargo and 15,000 feet of lumber for St. George.

About 300 tons of supplies and 26,000 feet of lumber, which could not be taken by the *Nanshan* from Seattle, were forwarded August 28, to Unalaska on the Pacific American Fisheries steamer *Catherine D*. The supplies delivered by the *Catherine D* were then transported to the Pribilofs by the *Nanshan*, which made a trip from the islands to Unalaska for the purpose. The *Nanshan* was unable to make delivery of about 155 tons of the coal aboard for St. Paul Island, and it was accordingly left at Unalaska for subsequent delivery by the Bureau's vessel *Eider*.

FIG. 1.—FISHERIES VESSEL "EIDER," TENDER FOR PRIBILOF ISLANDS.

FIG. 2.—TRACTOR HAULING SEALSKINS FROM KILLING FIELD TO SALT HOUSE, ST. PAUL ISLAND.

Emergency supplies of coal and salt were purchased at Unalaska and delivered at the Pribilofs by the Coast Guard cutter *Unalga* in July.

The *Eider* made a trip from Unalaska to the Pribilofs in November. Cargo consisted of about 28 tons of the coal left by the *Nanshan* and approximately 20 tons of general supplies, part of which had been purchased by natives and some by employees at the St. Paul radio station.

USE OF TRACTORS.

For use in hauling seal carcasses to the by-products plant and sealskins to the salt houses, as well as for uses in connection with the upkeep and improvement of the St. Paul Island station, four Gray tractors were sent to the island on the *Nanshan*, arriving in September. These tractors will supplement the use of mules and autotrucks. Eight trailers were purchased and shipped with the tractors.

The tractors were secured from the War Department from unused stock originally intended for military use overseas. After the transportation problem at St. Paul Island, especially in respect to the lack of roads and sandy character of the surface had been given due consideration, the War Department recommended the Gray tractor as the most suitable. This is a wide-drive drum type. Instead of the customary two wide rear driving wheels, there is a single drum or wheel the full width of the road. Some use of the tractors in the fall indicates that they will prove a helpful addition to the equipment at St. Paul Island. Operations on St. George Island are much more concentrated near the village, hence there is less use for tractors than on St. Paul.

STEAMER "ROOSEVELT."

The steamer *Roosevelt*, which had been used in 1917 and 1918 for transporting the major portion of the supplies required by the Bureau at the Pribilofs and for bringing back sealskins and other products, was found to be in need of extensive repairs. The vessel was placed in dry dock at the Puget Sound Navy Yard April 21, 1919, where it was estimated that the cost of repairs and improvements would be approximately $186,000. A decision was reached that the vessel did not warrant such a large expenditure, and steps were taken to dispose of it through sale. The *Roosevelt* was accordingly advertised for sale, and on July 15 was disposed of at public auction to Capt. M. E. Tallakson for $28,000. Final payment was made and the sale approved July 30.

SCHOONER "EIDER."

As stated in the corresponding report for 1918 plans were under way for acquiring by construction or through purchase a suitable vessel of convenient size for local use at the Pribilofs. Early in 1919 it was realized that the appropriation of $20,000 available was not adequate, and that it would be necessary to secure a supplemental appropriation from Congress. An additional appropriation of $7,500 was obtained in a deficiency act approved July 11, 1919. Thus a total of $27,500 became available.

Failing to secure satisfactory bids for the construction of a vessel, the Bureau finally purchased the power schooner *Idaho* from Lee & Brinton, of Seattle, for $26,500. The vessel was renamed *Eider*. Its

registered dimensions are: Length over all, 88 feet; beam, 19.4 feet; depth, 9.2 feet; draft loaded, 9 feet. The registered tonnage is 76 gross and 52 net. The vessel is equipped with a 3-cylinder 110-horsepower Frisco Standard engine, together with appropriate auxiliary machinery. The *Eider* was built in 1913, and had been employed in the offshore halibut fishery. Certain alterations were made to the vessel, which provided two additional staterooms and a room for wireless equipment. The cost of these alterations were included in the purchase price. The vessel was equipped through the Navy Deparment with a one-half kilowatt wireless outfit and a 1-pound gun.

The *Eider* sailed from Seattle October 26 for Unalaska, arriving there November 17. Stops were made en route at Kodiak and King Cove. At Unalaska there were taken aboard about 28 tons of coal for St. Paul Island and about 20 tons of supplies for the radio station and natives at St. Paul. The vessel arrived at St. Paul November 23, and after discharging cargo left the 25th. It was necessary to keep aboard about 10 tons of coal for ballast. A stop was made at St. George, landing mail at Zapadni, and leaving for Unalaska November 26. Unalaska was reached the following day. Dr. Charles E. Johnson was a passenger from St. Paul to Unalaska.

SHIPMENT AND SALE OF OLD BONES.

One shipment of old bone was made from the Pribilofs in 1919. The material was transported from the islands by the U. S. S. *Saturn*, and was landed at San Francisco in June. The gross weight of the shipment, including sacks, was 106,131 pounds. In determining net weight a deduction of 5 pounds per sack for each of the 1,766 involved was made, and from the resulting remainder a deduction of 25 per cent was made for moisture. The net weight was 72,973 pounds, and on this basis the material was sold to the Pacific Bone, Coal & Fertilizer Co. at $31 per ton. From the proceeds, $1,131.08, there were deducted $25.71 for expenses connected with the sale and $527.55 for making payments to the natives for collecting the bone. The balance, $577.82, was turned into the United States Treasury.

The shipment, by gross weight, originated as follows: St. Paul Island, 9,052 pounds unground bone; St. George Island, 56,584 pounds unground, 40,495 pounds ground.

The following statements present in tabular form the results of bone-collecting operations on the Pribilofs in the calendar years 1916 to 1918, inclusive. In addition to that shipped, there were perhaps 50 tons of bone practically ready for shipment at the Pribilofs at the end of 1919.

EXPENDITURES AND RECEIPTS ACCOUNT COLLECTION AND SALE OF OLD BONES, PRIBILOF ISLANDS, CALENDAR YEARS 1916 TO 1919, INCLUSIVE.

Approximate date of arrival at Seattle.	Net weight in pounds.	Expense of sale.	Receipts, less expense of sale.	Payments to natives.	Amount covered into United States Treasury.
August, 1917	32,170	....	$321.70	$179.68	$142.02
January, 1918	161,400	$333.18	2,087.82	807.00	1,280.82
July, 1918	80,092	70.75	1,090.58	492.21	598.37
September, 1918	97,408	59.10	1,353.31	487.04	866.27
January, 1919	28,111	65.83	341.77	140.50	201.27
June, 1919	72,973	25.71	1,105.37	527.55	577.82
Total	472,154	554.57	6,300.55	2,633.98	3,666.57

BY-PRODUCTS PLANT.

It was planned to operate the by-products plant, erected on St. Paul Island in 1918 for the reduction of seal carcasses into fertilizer and oil, to its full capacity in the season of 1919. Owing to a number of unforeseen difficulties, however, principally an unavoidable shortage of coal, it was possible to carry on operations for brief periods only. The output, including small quantities prepared in an experimental way in 1918, was transported to Seattle on the U. S. S. *Nanshan* in the fall. It consisted of 3,000 gallons of oil and 20,568 pounds of fertilizer, known to the trade as "meal." The oil and fertilizer were sold separately, to the highest bidder in each case. Four hundred and fifty gallons No. 1A clear and 450 gallons No. 2A clear were sold at $1.50 per gallon, 850 gallons No. 2B crude and 250 gallons No. 3 crude at $1.20, 700 gallons No. 1B crude at $1, and 300 gallons foots at 90 cents. The total amount received for the 3,000 gallons was $3,640. The 20,568 pounds of fertilizer "meal," sold at $75 per ton, the amount received being $771.30.

A. Christoffersen, a by-products expert, was employed as special assistant for several months in connection with the work of the plant.

STUDY OF SEALING METHODS.

In order that the quality of the sealskins placed on the market by the Government might be improved if possible, the Bureau carried on in 1919 a special investigation. William P. Zschorna was specially employed a number of months for the work. He first made a study of the methods of handling sealskins at St. Louis through the various processes involved in their dressing, dyeing, and machining. Skins which had developed defects in the various processes were also noted. The work at St. Louis was then supplemented by field work at the Pribilofs. Attention was given to the methods employed in driving and killing seals and in the curing of the skins. Quite elaborate experiments were carried on as to the matter of curing skins, and the particular skins involved were later carefully followed in the course of regular processing at St. Louis.

The investigation resulted in a number of recommendations, four of which were deemed of sufficient practicability to warrant further study and some actual modification of previous methods for the season of 1920. They were: First, to make drives whenever possible the evening before the killing; second, to expend a greater amount of work in handling seals immediately before killing in order to keep them cool; third, to cool and clean skins before salting by immersing them in salt water for a number of hours; and fourth, to employ more elaborate methods in the salting and curing of skins. The work will be continued in 1920. The proposed plan of washing and cooling skins before salting will be tried out in an exhaustive way.

The investigation in 1919 also gave attention to the question of how much blubber should be left on sealskins of various sizes. As a result of the experiments of last season, it seems that skins do not cure as thoroughly in places where the blubber is unusually thick. The logical remedy appears to lie in removing part or much of the blubber. It is possible that it may not be feasible to fully remove the blubber on account of the danger of flaying or cutting the skins,

especially in the case of the smaller ones. There is naturally less danger from this source in removing blubber from the heavy large pelts as the hide is much thicker. Instructions will be issued that 1,000 skins be blubbered at the islands in 1920 in order to work out the best practice along this line. After results have been observed at the dressing and dyeing plant, it will be possible to determine the most advantageous course of action.

NATIVES OF PRIBILOF ISLANDS.

HEALTH CONDITIONS.

The health of the natives on both St. Paul and St. George Islands throughout the year 1919 was generally fair. The native community on St. George Island numbers about 120 people. For the full census year from April 1, 1919, to March 31, 1920, not one death occurred. When the circumstances and conditions are taken into consideration this is a noteworthy fact.

Undoubtedly more suitable supplies of food and clothing are telling in their effect upon the general health of the natives of the Pribilofs. Much remains, however, to be done. A great deal depends upon the attitude and interest taken in the natives by the employees of the Bureau stationed on the islands, but present efforts are hampered and the best results will never be attained until better housing conditions are provided on both islands, as well as facilities for obtaining suitable supplies of water for domestic purposes. To rebuild the natives' houses and install a water-supply system will require an expenditure of funds which can not be allotted from the current appropriations for the Alaska service, and specific action, therefore, is necessary by Congress in the matter. Such action can not be taken too soon, for every year the work is postponed means so much added loss. The efficiency with which the Department's work at the islands is performed depends to a degree, which is not likely to be overestimated, upon the maintenance of a community of strong, healthy laborers.

The people on the Pribilof Islands were exceptionally fortunate in 1919 in that they were not subjected to the ravages of the influenza which worked such havoc among other native communities in the Bering Sea region. At Unalaska, the port through which practically all travel between the Pribilof Islands and the rest of the world passes, there were upwards of 40 deaths due to influenza, most if not all the victims being natives. When the conditions at Unalaska became known at the Pribilofs, steps were immediately taken by the physician at St. Paul, through the agent in charge, to prevent the arrival of any vessel at the Pribilofs coming from Unalaska. The necessary action was taken, and while it resulted in depriving the Bureau of some assistance in sealing operations, the islands were in all probability spared from a very serious epidemic. The results secured by the Bureau's physicians during the year were very satisfactory in all matters requiring their attention.

A not unexpected epidemic of colds and allied disorders occurred shortly after the arrival of the first vessel at the islands in the spring of 1919. This was repeated again, on St. Paul Island at least, upon the arrival of the *Nanshan* later in the season.

SCHOOLS.

Statutory provision is made for three school teachers for the Bureau's work at the Pribilof Islands. Since the native population is considerably larger on St. Paul Island than on St. George Island, it has been the custom for the Bureau to detail two of the teachers to the former island and one to the latter. To do justice to educational matters on St. George Island, two teachers are necessary, and to help out until other provision is made a temporary assistant is employed from time to time at a nominal salary to teach a number of the smaller children and to give instruction in household duties to some of the larger ones. An additional teacher to give full time to the work is urgently needed on St. George.

The Bureau is fortunate in being able to have the services of persons who are genuinely interested in their work, and in the last few years the results secured have been highly satisfactory. The Bureau has made special effort to provide suitable materials for carrying on the school work. The scope of this work includes not only instruction along the usual formal lines but in practical matters as well.

St. Paul Island.—For various reasons the school year 1918–19 was shorter than usual. The number of days in which formal instruction was given was 116, and the total number of pupils enrolled was 59. Percentage of punctuality was 97 and attendance 98.

Much attention was devoted to the teaching of English. The tenacity with which the natives of the Pribilofs cling to the use of the Aleut tongue is remarkable. The teachers on St. Paul, when taking up their work in the latter part of 1918, after having been absent on leave during the summer, noted how much the children had lost in their ability to use English in the preceding vacation. Since Aleut is not written on St. Paul Island, anything which tends to encourage composition upon the part of the children tends to stimulate the use of English.

The teachers state that the school library was well patronized by the pupils and that several of the young women of the village are regular applicants for books.

By way of indicating some other lines of instruction afforded by the St. Paul school, the following extracts are taken from the report for the year 1918–19 by Mr. and Mrs. Haley:

> Sewing has been kept up all the year. The sewing classes are always popular. This year there have been three classes: The senior girls, the junior girls, and a class of boys. The materials furnished directly by the Bureau have been greatly enjoyed. Each of the senior girls has made by hand a pair of bloomers and a hemstitched towel. The class of boys (the oldest boys of the junior school) has learned to use thimbles, to sew "over and over," and to hem. This class was started at the request of the boys themselves. The junior girls did all their work with one kind of stitch. The sewing lessons have alternated with darning lessons, but darning does not appeal to the girls as sewing does. The knitting class did not begin until after Russian Christmas. It was taught this year, as last year, by a native woman.
>
> The young women of the island were given an opportunity to come to the junior school building once a week after school hours for a reading class. They chose American history stories for the class work. The severity of the weather during the winter made this gathering rather irregular.

St. George Island.—The 1918–19 school year on St. George Island began October 7, 1918, and ended April 1, 1919. The initial enrollment consisted of 32 pupils—17 girls and 15 boys. Due to the departure of one boy from the island and the death of another, the enroll-

ment was subsequently reduced to 30. The number of days in which the school was in session was 92½. On this island also the school year 1918–19 was unavoidably shorter than is desirable. The percentage of punctuality was 99.96; attendance, 97.6.

No important changes were made in the method of instruction followed the preceding year. Special methods devised by the teacher on St. George were instrumental in securing and holding the interest of the children. Special emphasis was given to encouraging the use of English.

The importance of cleanliness, fresh air, and exercise was made a matter of instruction. The book, Gulick's Good Health, was taken up in the reading work of the most advanced class. A very good brief history of the Pribilof Islands, going back to the early discoveries of the Russians in Alaska, was prepared by Mr. Crompton and was taken up as a regular subject in the school.

Books in the school library were in good demand, an average of 10 volumes being exchanged daily. The services of a native boy who returned from the Salem Indian Training School, Chemawa, Oreg., in 1917, were utilized to assist with the school work. While the help of a native is essential under the circumstances, such assistance can not possibly be considered as satisfying the requirement for an additional teacher for St. George.

A temporary assistant was employed to aid in school work on St. George. The services of this assistant were devoted to instructing a number of the smaller children who had not yet entered the regular school, and also to teaching sewing and giving instruction in other matters pertaining to domestic economy.

ATTENDANCE AT SALEM INDIAN TRAINING SCHOOL, CHEMAWA, OREG.

The Salem Indian Training School maintained by the Government at Chemawa, Oreg., affords an opportunity for the young people of the Pribilofs to receive training in addition to that which they obtain at the local schools maintained on the islands by the Bureau.

In 1919, one boy, Laurence Merculief, from St. George Island, entered the training school, and four St. Paul boys, John Emanoff, Alfey Melovidov, Daniel Shabalin, and Peter T. Kochergin, returned home. Agrifina Fratis and Martha Fratis, of St. Paul Island, left the school June 15, 1919, but did not return to St. Paul. In the spring of 1920 they were at Marshfield, Oreg.

Pribilof Islands Natives at Salem Indian Training School, Dec. 31, 1919.

Fratis, Akalina [a]	Resident of St. Paul Island.
Fratis, Ouliana	Do.
Stepetin, Nicolai	Do.
Stepetin, Vasilii	Do.
Lekanof, George	Resident of St. George Island.
Merculief, Laurence	Do.

SAVINGS ACCOUNTS.

Certain of the Pribilof Islands natives have personal funds in the custody of the U. S. Commissioner of Fisheries as trustee. These

[a] Mother of Ouliana Fratis and employed at the school.

funds are still on deposit with the Washington Loan & Trust Co., Washington, D. C., and draw interest at 3 per cent per annum, calculated on monthly balances. During the year 1919 three new accounts were opened by natives of St. Paul Island.

On January 1, 1919, the balance was $3,174.65. Interest credited July 1, 1919, amounted to $47.61, and on December 31, 1919, $46.54, making a total of $94.15 for the entire year. Funds in the sum of $38.70 were deposited during the year. Withdrawals amounted to $213.93. The balance on December 31, 1919, of $3,093.57 is in accordance with the itemized statement which follows:

PRIBILOF ISLANDS NATIVES' SAVINGS ACCOUNTS IN CUSTODY OF U. S. COMMISSIONER OF FISHERIES, AS TRUSTEE, DEC. 31, 1919.

ST. PAUL ISLAND.	
Bourdukofsky, Apollon	$87.78
Bourdukofsky, Peter	58.91
Diakanof, Auxenia (Mrs. C. H. Hope)	24.98
Emanoff, Alexey [a]	286.94
Fratis, Agrifina [b]	90.17
Fratis, Akalina [b]	531.68
Fratis, Martha [b]	90.17
Fratis, Ouliana [b]	90.17
Gromoff, Iuliania	388.24
Hanson, John	4.78
Kozloff, Parascovia	85.40
Krukoff, Iuleta	8.64
Mandregan, Alexandra M	9.93
Melovidov, Alfey	41.87
Melovidov, Anton	3.60
Melovidov, Iosef	41.87
Merculieff, Dosofey	37.53
Merculieff, Makary	37.53
Merculieff, Mariamna	37.53
Merculieff, Paul	14.70
Merculieff, Terenty [a]	$37.53
Oustigoff, Peter	23.72
Pankoff, Agrippina	228.78
Pankoff, Maria M	41.87
Sedick, Feofania [c]	13.09
Sedick, Laventy [c]	13.09
Sedick, Leonty [c]	13.09
Sedick, Marina	.38
Tetoff, Vikenty M	41.86
ST. GEORGE ISLAND.	
Galanin, Mary	236.68
Lestenkof, Michael	114.64
Merculief, Agrifina	62.65
Merculief, Joseph	23.57
Merculief, Polyxenia	11.92
Philemonof, Mary [a]	115.14
Philemonof, Zoya [d]	113.91
Shane, Michael	28.78
Zacharof, Emanuel	.45
Total	3,093.57

LIBERTY BONDS.

The 43 Liberty bonds of the fourth issue, amounting to $2,150, were forwarded on July 22, 1919, to the St. George natives who subscribed to them, with the exception of one $50 bond which was disposed of by the owner at par value.

The 44 Liberty bonds of the third issue, amounting to $2,200, were forwarded, on July 22, 1919, and March 30, 1920, to the respective natives of St. George and St. Paul Islands, who subscribed to them, with the exception of one $50 bond which was disposed of by the owner at par value.

From time of purchase the Commissioner of Fisheries had held these bonds in a safe-deposit box at the Washington Loan & Trust Co., Washington, D. C. In view of the fact that all bonds have been forwarded to their owners, the box is no longer retained by the Bureau.

[a] Deceased, estate undivided.
[b] Not living on islands in 1919.
[c] New accounts opened in 1919.
[d] Married to Michael Borenien in 1918. Now deceased.

PAYMENTS FOR TAKING SEALSKINS.

In 1919 the general plan followed the previous year for making payments for the taking of sealskins at the Pribilofs was continued. By the terms of the contract with Funsten Bros. & Co., that firm provides funds for paying persons engaged in killing and skinning seals and salting and handling sealskins, or otherwise employed in connection therewith, and secures reimbursement from the proceeds of sales of skins. Payments in 1919 covered the salary of one general assistant, wages of two cooks and of a number of Aleutian Islands natives temporarily at the Pribilofs, and payments to Pribilof natives in accordance with numbers and sizes of seals killed. It was arranged that A. H. Proctor, the Bureau's agent at St. Paul Island, should make the necessary disbursements for both St. Paul and St. George Islands. He was bonded in the amount of $15,000 by the United States Fidelity & Guaranty Co.

In July, 1919, the sum of $21,000 was deposited by Funsten Bros. & Co. in the Seaboard National Bank, Seattle, Wash., to Mr. Proctor's credit. An additional deposit of $2,850 was made by Funsten Bros. & Co., on January 22, 1920, to provide for payment of liabilities until the beginning of active work in 1920, a total deposit of $23,850. Through December 31, 1919, expenses incurred amounted to $22,318, leaving a balance of $1,532 to apply on 1920 operations.

The items of expenditure for the calendar year 1919 paid from funds advanced by Funsten Bros. & Co. were as follows:

Salary of general assistant, April to December	$1,350.00
Wages of 2 cooks	750.00
Wages of Aleutian Islands natives at St. Paul	4,055.00
Amount earned by St. Paul Island natives	14,093.00
Amount earned by St. George Island natives	2,070.00
Total	22,318.00

The natives of the Pribilofs were paid 50 cents each for skins taken from seals up to and including those of the 6-year-old class and $1 per skin for those taken from seals of the 7-year-old class and upward, except that after August 10 payment for skins of the 6-year-old class was increased to $1 per skin. No payments were made for skins of seals under the 6-year-old class killed for food purposes after August 10.

In determining the respective amounts due individually for sealing operations, the Pribilof natives were divided into classes according to their ability. Inasmuch as the taking of skins is necessarily cooperative work, each person can not individually take a definite number of skins.

St. Paul Island.—In the calendar year 1919 there were taken on St. Paul Island 24,053 skins. For these, after deducting skins from seals killed for food, payments were made on the basis of 50 cents each for 18,342 skins and $1 each for 4,822 skins. The division was as follows:

DISBURSEMENTS TO ST. PAUL NATIVES FOR SEALING OPERATIONS, CALENDAR YEAR 1919.

Classification.	Number of men.	Share of each.	Total.	Classification.	Number of men.	Share of each.	Total.
First class	24	$367.50	$8,820.00	Second boys' class	4	$5.00	$20.00
Second class	11	294.00	3,234.00	Undivided credit [a]			645.00
Third class	3	239.00	717.00	Additional compensation [b]			100.00
Fourth class	2	183.50	367.00				
Fifth class	2	50.00	100.00				
Boys' class	9	10.00	90.00	Total	55		14,093.00

[a] For 645 seals 6 years and over taken Nov. 8 to Dec. 31. Fund later divided as follows: 22 first-class men, $18 each; 11 second class, $16 each; 3 third class, $13 each; 1 fourth class, $10; and 4 fifth class, $6 each.
[b] Allowed 2 native foremen.

St. George Island.—The number of skins taken on St. George Island in the calendar year 1919 was 3,768. No skins were taken on this island after August 10 except from seals killed for food purposes, and no payments were made for taking such skins. Of the 3,768 skins taken, payment for 2,768 was on the basis of 50 cents each and for 586 on the basis of $1 each. The natives participating in the operations were divided into six classes according to their ability and the amount of work performed. The division was made as follows:

DISBURSEMENTS TO ST. GEORGE NATIVES FOR SEALING OPERATIONS, CALENDAR YEAR 1919.

Clasification.	Number of men.	Share of each.	Total.	Classification.	Number of men.	Share of each.	Total.
First class	15	$78.50	$1,177.50	Boys' class	1	$29.50	$29.50
Second class	6	63.00	378.00	Additional compensation [a]			100.00
Third class	2	52.00	104.00				
Fourth class	5	44.00	220.00				
Fifth class	2	30.50	61.00	Total	31		2,070.00

[a] Allowed 2 native foremen.

PAYMENTS FOR TAKING FOX SKINS.

As in previous seasons, the natives of the Pribilofs were paid $5 for each fox skin taken in the season of 1918–19. The 144 skins taken on St. Paul Island yielded the natives of that island an aggregate of $720, which was divided among 38 persons in amounts varying in accordance with their respective earnings. The aggregate of $2,765 due the St. George natives for the 553 skins taken was divided among 29 persons in accordance with their respective earnings. The payments were made from the proceeds of the sale of the skins

CENSUS.

As in previous years, formal record was made as of March 31 of certain important facts regarding the native inhabitants of the Pribilofs. On March 31, 1919, the number of native inhabitants on St. Paul Island was 188 and on St. George Island 122, a total of 310. The corresponding figures for March 31, 1918, were: St. Paul Island, 199; St. George Island, 123, a total of 322. These figures show a total decrease of 12 in the year ended March 31, 1919. When the natives away from the islands, prospectively only temporarily, were taken into consideration, the total number on March 31, 1918, was

335 and on March 31, 1919, 329. On the basis of these last figures there was a decrease of 6 in the year ended March 31, 1919.

RECAPITULATION OF CENSUS OF NATIVES, MAR. 31, 1919.

St. Paul Island:	
Resident population Mar. 31, 1918	199
Births in year ended Mar. 31, 1919	11
	210
Arrival in year (from Atka Island)	1
	211
Deaths in year	10
	201
Departures in year, permanent—	
To St. George Island	3
To Unalaska	3
	6
	195
Departures in year, temporary—To Unalaska	7
Total native resident population, Mar. 31, 1919	188
Natives at Salem Indian Training School, Chemawa, Oreg.	10
Others temporarily residing elsewhere	8
Total natives accredited	206
St. George Island:	
Resident population Mar. 31, 1918	123
Births in year ended Mar. 31, 1919	4
	127
Arrivals in year (from St. Paul Island)	3
	130
Deaths in year	6
	124
Departures	2
Total native resident population Mar. 31, 1919	122
Native at Salem Indian Training School, Chemawa, Oreg	1
Total natives accredited	123

FUR-SEAL HERD.

QUOTA FOR KILLING.

On April 8, 1919, the Secretary of Commerce approved the Bureau's recommendation that the quota of seals to be killed at the Pribilof Islands in the calendar year 1919 be as follows:

QUOTA OF SEALS FOR KILLING IN 1919.

Age class.	St. Paul.	St. George.	Total.
3-year olds	13,000	2,000	15,000
4-year olds	1,700	300	2,000
5-year olds	800	200	1,000
6-year olds and over	14,500	2,500	17,000
Total	30,000	5,000	35,000

It will be noted that the quota provided for the killing of a large number of seals 6 years of age and upwards. The five years of restricted killing of seals, from August 25, 1912, to August 24, 1917, provided for by the act approved August 24, 1912, giving effect to the North Pacific Sealing Convention of July 7, 1911, had resulted in the accumulation of a large number of males far in excess of the number required to maintain the breeding strength of the herd at a maximum. Furthermore, it was felt that this surplus accumulation of males meant not only a loss of revenue to the Government through failure to market as many of the pelts as possible, but through damage to the herd itself on account of the increased fighting on the part of the male seals. It had always been believed that the pelts of older males taken after the development of the so-called wig were practically useless to furriers. Fortunately, experiments conducted at the new dressing and dyeing plant at St. Louis on a limited number of large skins taken at the Pribilofs had demonstrated that a skin from a large seal could be dressed and dyed in such a manner that it commanded almost as great a market value as skins from 3 and 4 year old seals. Under these conditions it was deemed highly desirable to include a considerable number of large seals in the quota for 1919.

In establishing the quota it was realized that the inclusion of 17,000 seals 6 years old or older would involve work possibly beyond the facilities of the Bureau to accomplish. The killing and skinning of a small seal and the curing of its skin is an easy task compared with similar operations in respect to a full-grown bull seal. It was also known that a further difficulty would be encountered by reason of the fact that surplus large males would be found on the hauling grounds in greatest abundance only in the early part of the season, being less and less in evidence there as the season proceeded. It was thought best, however, to fix the quota at the figures which the interests of the service demanded and to accomplish as much as possible under the circumstances.

Through the year 1919 there were killed 7,731 seals 6 years old and over. While the number taken was very much below the number planned, it is believed that much good has been accomplished in the way of reducing the number of surplus males and in affording the means for increasing largely the Government's revenue from the Pribilofs.

KILLINGS OF SEALS.

St. Paul Island.—During the calendar year 1919 there were killed on St. Paul Island 24,053 seals. Aside from a few seals killed for food and for scientific experimental purposes, they were obtained in 70 drives, the first on April 5 and the last on December 18.

St. George Island.—During the calendar year 1919 there were killed on St. George Island 3,768 seals. With the exception of a few, these were secured in 38 drives, the first on June 3 and the last on November 7.

The total number of seals killed on both islands in the calendar year 1919 was 27,821. The tables following show details in regard to the killings in 1919.

Seal Killings on Pribilof Islands in 1919.

ST. PAUL ISLAND.

Date.	Serial No. of drive.	Hauling ground.	Skins secured.
Apr. 5	1	Sivutch (Sea Lion Rock)	49
May 10	2	do	64
May —		Northeast Point	a 1
May 28	3	Sivutch (Sea Lion Rock)	115
June 11	4	Tolstoi	84
June 15	5	Vostochni	556
June 16	6	Reef	113
June 17	7	Zapadni and Little Zapadni	462
June 19	8	Morjovi and Vostochni	1,288
June 20	9	Polovina	323
June 21	10	Tolstoi	99
June 23	11	Zapadni and Little Zapadni	347
June 24	12	Reef	597
June 26	13	Morjovi	813
June 27	14	Vostochni	613
June 28	15	Polovina	197
June 30	16	Tolstoi, Lukanin, and Kitovi	286
July 1	17	Zapadni and Little Zapadni	873
July 2	18	Gorbatch	1,042
July 3	19	Reef	369
July 6	20	Morjovi	624
July 7	21	Vostochni	1,211
July 9	22	Gorbatch	1,029
July 10	23	Zapadni and Little Zapadni	894
July 11	24	Tolstoi, Lukanin, and Kitovi	412
Do	25	Gorbatch and Reef	719
July 14	26	Morjovi	919
July 15	27	Vostochni	328
Do			b 8
July 16	28	Gorbatch and Reef	1,259
July 17	29	Zapadni and Little Zapadni	551
Do	30	Tolstoi	168
July 22	31	do	184
Do	32	Lukanin and Kitovi	25
July 23	33	Gorbatch and Reef	332
July 27	34	Morjovi	658
July 28	35	Vostochni	512
July 30	36	Gorbatch	736
July 31	37	Reef	468
Aug. 1	38	Tolstoi	182
Do	39	Lukanin and Kitovi	72
Aug. 2	40	Zapadni and Little Zapadni	232
Aug. 5	41	Morjovi	469
Aug. 6	42	Vostochni	198
Aug. 7	43	Gorbatch	531
Do	44	Reef	182
Aug. 8	45	Zapadni and Little Zapadni	189
Aug. 9	46	Gorbatch	171
Do	47	Reef	82
Do	48	Lukanin and Kitovi	39
Do	49	Tolstoi	50
Aug. 10	50	Morjovi	153
Do	51	Vostochni	116
Aug. 22	52	Reef and Gorbatch	199
Aug. 23	53	Tolstoi	48
Aug. 25	54	Zapadni and Little Zapadni	106
Aug. 27	55	Vostochni	176
Do	56	Morjovi	51
Aug. 30	57	Tolstoi	41
Oct. 22	58	Reef and Gorbatch	175
Nov. 3	59	Gorbatch	122
Nov. 7	60	Reef	151
Do	61	Tolstoi	59
Nov. 10	62	Polovina	225
Nov. 14	63	Morjovi	247
Nov. 15	64	Vostochni	146
Nov. 26	65	Reef	47
Nov. 28	66	Gorbatch	49
Nov. 29	67	Tolstoi	41
Dec. 3		Zapadni	a 4
Dec. 5	68	Morjovi	60
Dec. 12	69	Tolstoi	27
Dec. 18	70	Morjovi	52
		Total	24,053

ST. GEORGE ISLAND.

Date.	Serial No. of drive.	Hauling ground.	Skins secured.
June 3	1	North and Staraya Artil.	16
June 6	2	East Cliffs	96
June 10	3	do	10
June 12	4	North and Staraya Artil.	41
June 14	5	Zapadni	33
June 15	6	East Cliffs	5
June 17	7	North and Staraya Artil.	65
June 19	8	East Reef and East Cliffs.	127
June 21	9	North and Staraya Artil.	161
June 23	10	East Reef	36
June 25	11	North and Staraya Artil.	107
June 26	12	Zapadni	58
June 30	13	East Reef and East Cliffs.	219
July 2	14	North and Staraya Artil.	242
July 3	15	Zapadni	32
July 5	16	East Reef and East Cliffs	146
July 7	17	North and Staraya Artil.	144
July 9	18	East Reef and East Cliffs.	164
July 10	19	Zapadni	25
July 12	20	North and Staraya Artil.	287
July 14	21	East Reef and East Cliffs.	154
July 16	22	North and Staraya Artil.	149
July 17	23	Zapadni	82
July 19	24	East Reef	176
July 21	25	North and Staraya Artil.	175
July 23	26	East Reef	122
July 28	27	North	84
July 30	28	East Reef	65
Aug. 2	29	North and Staraya Artil.	82
Aug. 4	30	East Reef	39
Aug. 5	31	Zapadni	43
Aug. 7	32	North and Staraya Artil.	109
Aug. 9	33	East Reef and North	60
Aug. 20-21		Zapadni	a 2
Sept. 1-30			c 6
Oct. 6			c 1
Oct. 20	34	North	107
Do	35	East Cliffs	121
Oct. 21	36	do	89
Oct. 30	37	East Reef	65
Nov. 4			a 8
Nov. 5			a 1
Nov. 7	38	East Reef	11
		Total	3,768

a Seals killed for natives' food. b Seals killed for experimental work. c Seals killed for fox food.

BRANDED SEALS.

Following the practice of previous years, there were killed on both St. Paul and St. George Islands in 1919 a number of the fur seals which had been branded when pups in 1912. The data obtained from year to year have been invaluable and are, of course, made more complete with the records of each succeeding year. The great value of the data lies in the fact that they are obtained from seals of known ages. The animals bearing the brand placed on pups in 1912 are the only ones which it has been possible to follow in a scientific way from year to year.

The animals were, of course, 7 years old in 1919. On St. Paul Island 11 were killed, on St. George Island 15. The following table gives certain information derived from them:

RECORDS OF BRANDED 7-YEAR-OLD MALE FUR SEALS KILLED ON PRIBILOF ISLANDS, CALENDAR YEAR 1919.

Serial No. of skins.	Date of killing.	Island.	Carcass weight.[a]	Carcass length.	Green-skin weight.		Trade classification.
			Pounds.	Inches.	Pounds.	Ounces.	
AP 6600	June 16, 1919	St. Paul	278.0	67.75	34	8	Wig.
AP 6601	June 24, 1919	do	337.0	73.00	29	8	Do.
AP 6603	June 24, 1919	do	323.0	65.50	31	8	Do.
AP 6604	do	do	481.0	74.25	48		Do.
AP 6605	do	do	370.0	72.75	34		Do.
AP 6606	do	do	205.0	61.50	15	8	Extra extra large.
AP 6701	Aug. 22, 1919	do	314.0	73.25	42		Wig.
AP 6702	do	do	330.5	73.25	37	8	Do.
AP 6703	do	do	274.0	74.50	36		Do.
AP 6827	Oct. 22, 1919	do	370.0	76.50	44	8	
G 6083	June 3, 1919	St. George	192.0	64.50	20		Wig.
G 6084	June 6, 1919	do	148.0	58.75	19		Do.
G 6089	do	do	226.0	72.50	31		
G 6092	June 11, 1919	do	413.0	72.00	40		Wig.
G 6093	June 17, 1919	do	191.0	66.50	23		Do.
G 6094	do	do	349.5	74.50	32		Do.
G 6095	do	do	360.0	72.75	40		Do.
G 6096	do	do	218.5	68.25	28		Do.
G 6097	June 19, 1919	do	215.5	63.75	23		Do.
G 6098	do	do	207.5	67.25	24		Do.
G 6099	do	do	212.0	66.50	28		Do.
G 6100	do	do	191.0	66.00	24		Do.
G 6101	do	do	486.5	78.00	64		Do.
G 6102	June 23, 1919	do	176.5	63.50	18		Do.
G 6126	July 2, 1919	do	323.0	68.25	32		Do.

[a] Seals were bled before being weighed.

Information in regard to the branded seals previous to 1919 may be obtained from preceding reports of the Alaska Fisheries and Fur Industries. It should be stated in this connection that an osteologic study of these branded seals is being made by Dr. G. Dallas Hanna.

AGE CLASSES OF SEALS.

Determination of the ages of seals killed is based on data derived from measurements of seals of known ages. The seals whose age was definitely known were those branded in 1912, of which a number have been killed from year to year. For practical purposes on the killing fields the length of the animal determines the age class into which it is placed, the length being the distance from the end of the

nose to the root of the tail. The following table shows the figures used for determining the ages of male seals:

AGE STANDARDS OF BODY LENGTHS OF SEALS.

Age.	Lengths of summer seals.	Lengths of fall seals.	Age.	Lengths of summer seals.	Lengths of fall seals.
	Inches.	*Inches.*		*Inches.*	*Inches.*
Yearlings	Up to 36.75	Up to 38.75	4-year olds	46 to 51.75	48 to 53.75
2-year olds	37 to 40.75	39 to 42.75	5-year olds	52 to 57.75	54 to 59.75
3-year olds	41 to 45.75	43 to 47.75	6-year olds	58 to 63.75	60 to 65.75

AGES OF SEALS KILLED ON PRIBILOF ISLANDS, CALENDAR YEAR 1919.

Age.	Summer (Jan. 1–Aug. 10), 1919.			Fall (Aug. 11–Dec. 31), 1919.			Grand total.
	St. Paul.	St. George.	Total.	St. Paul.	St. George.	Total.	
Yearlings	4		4	7		7	11
2-year olds	123	71	194	60	154	214	408
3-year olds	12,983	2,059	15,042	594	226	820	15,862
4-year olds	2,020	370	2,390	38	28	66	2,456
5-year olds	1,118	141	1,259	35	2	37	1,296
6-year olds	2,089	124	2,213	300		300	2,513
7-year olds and over	3,652	586	4,238	980		980	5,218
Cows [a]	38	3	41	12	4	16	57
Total	22,027	3,354	25,381	2,026	414	2,440	27,821

[a] The few cows reported above, about one-fifth of 1 per cent of the total take, shown in the table, were accidentally and unavoidably killed. Every possible effort is made to avoid the killing of cows, but persons familiar with conditions at the islands will readily appreciate that once in a great while a cow is killed.

CENSUS.

Following the practice of previous years a census of the fur-seal herd was taken in the summer of 1919. The increase in size of the herd from year to year renders it increasingly difficult to enumerate the animals and each year resort must be had to approximations and estimates to a greater extent than before. The difficulties can be eliminated to some degree by the erection of observation stations and perhaps the construction of walkways through the rookeries. The Bureau will take steps to bring about improvements of this character as soon as possible. Full information in regard to the census of 1919 is contained in the report, printed on pages 106 to 117, by Dr. G. Dallas Hanna, who was in immediate charge of the census work.

The following is a comparative statement of the numerical strength of the various elements of the herd in the years 1912 to 1919, inclusive:

GENERAL COMPARISON OF RECENT CENSUSES OF THE SEAL HERD.

Class of seals.	1912	1913	1914	1915	1916	1917	1918	1919
Harem bulls	1,358	1,403	1,559	2,151	3,500	4,850	5,344	5,158
Breeding cows	81,984	92,269	93,250	103,527	116,977	128,024	142,915	157,172
Surplus bulls						8,977	17,110	9,619
Idle bulls	113	105	172	673	2,632	2,706	2,444	2,239
Young bulls (chiefly 5-year-olds)	199	259	1,658					
6-year-old males					11,167	15,397	13,755	8,991
5-year-old males				11,271	15,494	14,813	11,941	5,282
4-year-old males	100	2,000	9,939	15,848	15,427	16,631	7,114	5,747
3-year-old males	2,000	10,000	13,880	18,282	19,402	19,507	9,117	13,596
2-year-old males	11,000	15,000	17,422	23,990	24,169	26,815	30,159	33,081
Yearling males	13,000	20,000	23,068	30,307	33,645	38,013	41,595	46,444
2-year-old cows	11,000	15,000	17,422	23,990	24,245	26,917	30,415	33,287
Yearling cows	13,000	20,000	23,067	30,306	33,646	38,018	41,608	46,447
Pups	81,984	92,269	93,250	103,527	116,977	128,024	142,915	157,172
Total	215,738	268,305	294,687	363,872	417,281	468,692	496,432	524,235

SPECIMENS FOR SCIENTIFIC PURPOSES.

In 1919 there were collected for the California Academy of Sciences, at San Francisco, a number of specimens of fur seals for its use in completing a fur-seal habitat group which is one of an elaborate series of groups installed at the academy's museum illustrative of natural history. The material included 3 adults from St. Paul Island and 3 adults and 13 pups from St. George Island. All the seals involved were animals found dead, with the exception of two accidentally killed on St. George Island. The appraised value of the collection was $43, which amount was paid by the academy and transmitted to the disbursing clerk of the Department for deposit in the United States Treasury.

FOXES.

The fox herds are a very important feature of the Bureau's operations on the Pribilof Islands. They produce considerable revenue for the Government each year, and the natives profit through payments made to them for taking the pelts. The revenue represents real production, for unless the herds were fostered by the Bureau's activities they would be reduced almost if not quite to the vanishing point. While the foxes would be able to subsist through the summer season on birds and other sources of food which they are able to secure unaided by man, few would survive the winter were seal meat not provided.

The fox herd is much larger on St. George Island than on St. Paul Island, at least the animals are apparent in larger numbers and the take of pelts each year is much greater. On St. George the feeding of foxes has been reduced to a system, on St. Paul it has not, but the matter is receiving very careful consideration. Natural and other factors on St. George have been much more favorable for controlling conditions than on St. Paul. In the matter of taking pelts, control of the food supply during the winter is almost as important as the supply itself. On St. George Island the beaches where foxes may resort for food are few and limited in extent. The seal-killing fields are limited to two, and both being small and close to the sea are easily cleaned of seal carcasses. The result is that the foxes are obliged to come to certain places for food put out for them. The food given them consists of seal carcasses saved from the killings of the preceding summer. The foxes accustomed to coming to certain places for food are easily induced to enter wire inclosures where the selection of those to be killed and of those to be released as breeders is a simple matter.

On St. Paul Island the open beaches are of considerable extent; the seal-killing fields are more numerous and some so situated that the removal of carcasses would be more difficult and has not been undertaken. It should be noted that foxes will feed in the winter season on seal carcasses left on the killing fields since the preceding summer. The absence of control of food supply in the winter on St. Paul makes it necessary there to capture them in steel traps. A fox once caught in a steel trap must be killed, and the selection of animals for the future breeding stock is an impossibility. From the standpoint of selecting breeders, the beneficial results of being able to observe the herd practically as a whole and to handle the individuals is strikingly shown in one way by the almost entire elimination of

white foxes from the St. George herd. On St. Paul Island the proportion of white foxes taken each year is very much larger. Furthermore, the releasing of animals as breeders insures that at least a minimum number has been reserved. When foxes are taken solely in traps, as on St. Paul, the maintenance of an adequate breeding stock must depend largely upon the judgment of the officer in charge. Whether it will be possible in time to follow profitably on St. Paul the methods employed on St. George is a problem for future solution.

TRAPPING SEASON OF 1919–20.

In the trapping season of 1919–20 there were taken on St. Paul Island 155 blue-fox pelts and 32 white-fox pelts, a total of 187; on St. George Island, 746 blue-fox pelts and 4 white-fox pelts, a total of 750 pelts. One additional white pelt was secured at St. Paul from a fox found dead in March, 1920. These figures show for both islands a take of 901 blue pelts and 37 white pelts, or a total of 938 pelts. The aggregate take was considerably larger than that for the preceding season, when 144 were taken on St. Paul and 553 on St. George, a total of 697. The take on St. George in the season of 1919–20 was the largest in many years.

On St. Paul trapping operations were carried on for about one week. Traps were set out December 2 and taken up the night of December 9.

The following extract is from a report submitted by Agent Proctor:

During the season of 1919–20 fox trapping was prosecuted under rather unusual weather conditions. The temperature was well above the freezing point, the ground was entirely free from snow, and light rains fell at intervals. This weather had been preceded by lower temperatures that had continued since well back into November, and it was therefore believed that the skins would be in prime condition.

In order that the fox runs would be well defined, the effort has heretofore been on this island to so time the trapping season as to get a period of clear weather, with the ground covered with a light layer of snow. Trips in the vicinity of the village made by the writer and reports from the more remote places by the natives showed that notwithstanding the absence of snow the fox runs were well defined in the soft ground and dead grass. Under the circumstances it was considered better to make a start under the conditions stated than to take a chance of encountering heavy winds with drifting snow at a later date.

Following the practice that has always obtained on this island, foxes were trapped in ordinary steel traps placed in the various runways and at other favorable points. The traps were secured to the ground by means of a chain and an iron stake driven into the soil. The traps and chains were then covered with grass and other suitable material to conceal them.

All the able-bodied workmen, with the exception of the native priest, were engaged in trapping, and each individual was supplied with as many traps as he was able to look after properly. In all, 42 men were engaged in trapping and an aggregate of 411 traps were employed by them.

In determining the length of the trapping period, the length of the immediately preceding seasons and the size of the catch were taken into consideration, it being thought that if the catch during the first few days of the present season had been noticeably large the season could be prolonged safely. A large catch would have been accepted as an indication that a greater number of young foxes had been brought to maturity this year than during the past years. The catch this season, however, during the first few days did not give this assurance, and the season was therefore confined to the seven actual trapping days originally determined upon. The traps were placed out in the late evening of December 2 and were taken up during the night of December 9, allowing seven full days for trapping operations.

The total number of skins secured during this period was 187 for a seven-day season, as against 144 skins secured in a five-day season in the preceding year. The average catch during the season of 1918 was 29 skins per day, with 39 men and 320 traps. The average number of skins taken daily during the present season by 42 men, with 411

traps, was 27 skins per day or 2 less per day than during the previous season. This would appear to indicate that the herd had made no such advances in numerical strength as to warrant a long period of trapping, with the attendant danger of over-trapping and an unwarranted reduction in fox life.

Under the conditions of fox life on this island it is difficult to see how any estimate of the actual number of foxes in existence can be secured. Unlike St. George Island, foxes here are rarely seen. During the summer and early fall the writer observed one family of two adults with three vigorous young in the cliffs near Zolotoi Sands, and several families were seen between Telegraph Hill and Halfway Point Lake and between Telegraph Hill and the vicinity of Little Zapadni rookery. A fox is rarely seen in the immediate vicinity of the village, though one did appear during the summer and loitered for a short time around our chicken house. Therefore, the only guide as to the number of foxes in existence is in the number taken from season to season. In earlier years this island supported a large fox herd, as indicated by the annual takes. The decrease in the herd, as indicated by the annual takes, appears to have followed the decrease in the number of seals taken and the gradual diminution in available food.

It would therefore appear that the problem of fox propagation here is, as on St. George Island, one of food. During the period from August, 1912, to August, 1917, the number of seals taken was limited to the number required for food for the native inhabitants. Little, if any, seal meat was available for the support of the foxes, and they had to subsist during that period almost entirely on the sea food of various kinds thrown up on the beaches. The increased takes of seals during the past two seasons have furnished abundant food, but the time has been too short to produce any marked effect upon the herd other than to show a satisfactory condition of nourishment, as indicated by the weights of the animals secured this season. The lightest fox taken this season was a blue female that weighed 4½ pounds, taken December 6, at Zapadni; the heaviest was a white male weighing 17½ pounds, taken at Tsammana on December 3. The average for the take was about 11 pounds. This may be accepted as a very satisfactory average weight for foxes of both sexes and all ages and indicates that the herd has found an abundance of food during the past year. Now that commercial sealing will proceed steadily there should be no shortage of food, and the physical condition of the herd should therefore show a steady improvement. With the animals in good physical condition and food abundant during all seasons of the year, we should expect larger litters to be brought to maturity and an early increase in the numerical strength of the herd. During the past sealing season killings were arranged, as far as practicable, with a view to leaving carcasses at various points on the island where foxes had been seen or where the ground formation was favorable for burrows, and this policy should be maintained.

As long as foxes are taken in steel traps nothing in the line of selective breeding can be considered, as every animal caught, regardless of its condition, must be killed. Neither can any effort be made to maintain approximately an equal number of animals of each sex. However, trapping by means of steel traps was not known to be detrimental to the herd in former years, when seals were killed in abundance and their carcasses permitted to lie on the ground in various places, and there is every reason to believe that with the continuation of commercial sealing the herd here can ultimately be brought to its former flourishing condition. How many years that will take can not at this time be foretold.

It has been suggested that the St. George method of fox trapping be tried on this island, but the writer is extremely doubtful as to the success of such an experiment. The St. George method of trapping foxes has been carried on only during the period of small seal killings and when the two killing fields used were kept free from carcasses during the winter season. The St. George killings are practically confined to the village killing field and to the killing field at Zapadni. During the period of the St. George method of trapping all of the seal carcasses on that island not required by the natives for food were placed in a silo and used for food at the village trap after the migration of the bird life. This method practically forced the foxes to resort to the village for food; that they come there solely for food during the winter season is shown by the promptness with which they abandon that feeding ground when the birds return to the island. To establish successfully the St. George method on St. Paul, traps would have to be built at several points and the killing fields would have to be kept free from food during the late fall and throughout the winter. This would place upon the working force an additional burden during sealing operations, and it is doubtful whether the results secured would warrant the necessary expenditure of money and labor at the present time.

The development of the by-products plant and extension of roads from the village to the various killing fields may materially change the conditions in the future, and

should that be the case a change in the trapping methods here might then be seriously considered.

All the skins secured here were dried as slowly as conditions at the various stations would permit, and it is believed that the objectionable "papery" condition of the skin is less noticeable than before. Special attention was given to this phase of the work. All the skins have been cased fur side in, in accordance with the instructions received from the Bureau.

On St. George Island fox trapping for the season of 1919–20 was carried on in the months of November and December, 1919, and January, 1920. Seven hundred forty-six blue-fox pelts, including 1 from an animal found dead, and 4 white-fox pelts, a total of 750, were taken. Two hundred twenty-nine male foxes and 225 females were released to insure the maintenance of a suitable breeding stock. It appears that the take of skins was the largest in 27 years. It should be noted that the number of animals released represents the least possible number of animals available at the time as a breeding stock. It is a moral certainty that not all the foxes on the island enter the traps during the season, and the reserved breeding stock is augmented by just the number which does not enter. Foxes released for breeders are marked so that if retaken the same season they will not be killed or charged a second time to the breeding stock if released.

In August, 1919, a small wire cage fox trap was constructed at Zapadni on St. George Island. It was used in the season of 1919–20 and was a complete success. It, of course, only supplements the fox-trapping house at the village. In 1919 arrangements were made for burying in the future the carcasses of foxes killed at the village. The plan adopted will remove all possibility of foxes having access to the carcasses and feeding on them with possible injurious results.

In the summer season of 1919 a supply of seal meat was preserved on St. George for use for fox food in the coming winter season.

In connection with the taking of fox pelts on St. George Island in the season of 1919–20 the following report has been submitted by Agent Crompton:

Summary of season.—Cold weather during the latter part of November made it advisable to open the season during that month as the foxes were visiting the feeding place in great numbers. Accordingly, trapping was begun the night of November 24, when 183 animals were handled in five hours, of which number 151 were killed. More foxes might have been taken on the opening night had proper facilities for handling the skins been available.

It was a fortunate thing that work was begun on November 24, as the following day brought warm winds and rain and for three weeks thereafter the thermometer did not register below 35° F. This very unfavorable situation forced the recommendation that the release of the breeding reserve be postponed until at least three-fourths of the expected catch of skins had been secured. Upon adopting this policy very few animals were released until after a total of 450 skins had been obtained.

Warm weather, with the consequent necessity for securing the skins before unprimeness developed, brought about the practice of all-night trapping. On these occasions the trap was opened about 7 o'clock in the evening and kept in operation until 6 or 7 o'clock the following morning. The foxes which had been caught before 12 midnight were disposed of at that hour; the remainder were attended to in the morning. After the first few nights of such work a system of operation was worked out by means of which it could be conducted without interfering with the regular duties of the following day.

All-night trapping was a decided success and the practice will be made a regular feature in future operations. Its advantages are (1) that more foxes may be handled during a given period, (2) that fewer nights of trapping are required, and (3) the animals are thus given more nights for undisturbed feeding. The work has the single danger of being too zealously conducted, in which case the foxes would be deprived of food for too long a period, if not permanently frightened off. During the season just past it was the practice to trap three or four, and on rare occasions five, nights

each week, no one being permitted to approach the fox house during the remaining nights. Except in emergencies it is felt that all-night trapping should be confined to not more than three nights in seven.

Observations.—The writer was present in the trapping room during several full nights and confirmed the well-known observation that low tides at night interfere with fox trapping. On one occasion, when the tide was extremely low during the midnight hours, 23 foxes were caught before 9.30 p. m., 3 foxes between that time and 3 a. m., and 38 were taken after 3 a. m. It was also repeatedly observed that the female fox is more nervous and timid than the male.

Garden Cove and Zapadni.—Trapping was conducted at two points other than the village, viz., Garden Cove and Zapadni. The work at Garden Cove, where a string trap was used, ended in a complete failure after 10 nights of trapping. It is not believed that a cage trap could be advantageously operated there.

The new cage trap at Zapadni was a great success. One hundred and thirty-four foxes were handled there during 20 nights, as against 38 animals in 18 nights of the preceding season. Of the foxes handled at Zapadni this season 77 were taken in four nights. The trapping work at Zapadni was placed in charge of only the most responsible of the native men and these were under definite orders as to the disposition to be made of the different classes of foxes caught. Telephone communication was continuous. Fox food has been periodically exposed at Zapadni since trapping ceased, and it is the intention to prepare a larger amount of food there next season.

Close of season.—Trapping was vigorously conducted along the lines indicated in the preceding paragraphs until, on January 30, the condition of the furs made it advisable to close the season. With a grand total of 1,204 foxes handled, this was the most successful season on this island since 1900-1901, when 1,335 animals were caught. With the single exception of the winter mentioned, it exceeds any season since 1890. In point of the number of pelts taken, it surpasses any season since 1892–93. These results speak high praise for the management of the foxes since the close of the last lease, when the herd was in an unsatisfactory condition.

Condition of furs.—Instructions were received to the effect that observations should be made to determine the relation of weather conditions to the primeness of the fox skins. Such observations as could be made on the pelts at this place showed that the relation is direct.

During a normal season the fur of the blue fox should certainly be prime between the dates December 1 and January 31, if not earlier and later than those dates. The skins taken on November 24, 1919, showed very dark on the flesh side, but the fur appeared to be in good condition. During the very warm and wet weather of early December the skins were fully furred but showed a tinge of reddish brown on the guard hairs. However, before the end of that month two unprime skins were noted on animals released for breeding, and it is not to be doubted that the unseasonable high temperatures of the fore part of the month had caused this condition. The statement is ventured that during a normal winter no unprime skins will be seen during the month of December.

During the greater part of January the weather was cold, with the result that the unprimeness threatened in the preceding month did not materialize until late in January. It is the writer's opinion that some of the finest pelts of the season were taken during early January.

Weights of foxes.—The following figures will be of interest and should be given special attention in the consideration of the recommendation which will be offered in connection therewith:

	Pounds.		Pounds.
Lightest male fox killed	7.00	Lightest male fox released	10.00
Heaviest male fox killed	22.00	Heaviest male fox released	21.00
Average male fox killed	13.09	Average male fox released	13.72
Lightest female fox killed	5.00	Lightest female fox released	8.00
Heaviest female fox killed	16.00	Heaviest female fox released	19.00
Average female fox killed	10.10	Average female fox released	11.00

Nearly all foxes handled were in good condition and carried heavy layers of fat. Except in rare cases, where a very vigorous young fox happened to weigh just within the minimum limit, all light-weight animals were killed. Only 9 such males and 11 females, weighing 10 and 8 pounds, respectively, were released as breeders; all others released were above those weights.

It is recommended that the minimum-weight limits for animals to be released for breeding be slightly increased; that the minimum for breeding males be set at 11 pounds and for breeding females at 8½ pounds, an increase of 1 pound on the former limit for each sex. Such a course will naturally cause more weights to approach the

minimum limits but it is possible that the average may again draw upward in a few years as a result of the practice. If at any time the average weights are found to be too near the minimum it will be a simple matter to revert to the former rule and nothing can be lost by the experiment. When the average weight of all male foxes is more than 13 pounds and the average weight of all female foxes is over 10 pounds, the minimum limits of 11 and 8½ pounds are but proper.

Breeding reserve.—The recommendation that the breeding reserve be increased to 225 pairs was made in the belief that such a change was the most certain manner in which the number of foxes on the island could be positively increased and, in view of the large number of foxes handled, the change could be well afforded this year. The release of 225 pairs this season should be followed (as food and other factors allow) by further small increases each season.

As in previous years, the breeding animals were selected with great care. Weight and general vigor, age, condition of fur, and depth of color in the fur were the principal points upon which an animal's fitness was decided. No old or crippled animals were released even though the fur was of the best.

Prospect for coming season.—There is no reason known at this time why the catch of foxes during the winter 1920–21 should not exceed the number taken this season by at least 200 animals. Ideal conditions attending, a catch of 1,000 skins plus 500 breeding animals is more than a remote possibility.

Feeding of foxes.—Feeding of the foxes was begun on October 13, 1919, is being continued at this time, and will not be stopped until late April. The food was put out in the usual manner in the neighborhood of the trap, the amount being gauged by the appetite of the animals. It was always the intention to place more food on the feeding ground than the foxes could consume in a single night. The largest amount consumed in a single night was approximately 1,600 pounds.

Referring to the possibility of needing whale meat for fox food during the coming winter, it is no longer felt that such a step will be necessary. After the experience of the past winter it is believed that if all seal meat not used as natives' food is carefully preserved as fox food and the accumulation judiciously fed during the necessary period that no shortage will be encountered. There should be, however, vigorous trapping in the early winter for the purpose of reducing the number of feeding animals. No efforts will be spared toward making the supply of fox food as large as will be possible with the number and sizes of seals which will be available for killing.

Lack of facilities.—There is great and urgent need of better facilities for caring for the fox skins. Owing to the lack of room in the crowded shop, it is very difficult to handle more than 125 skins at one time. This not only gives poorer results but is important when we consider that a catch of 200 skins on the opening night of the season may be expected in the near future.

The proposed new shop will do much to relieve the lack of space and will provide a place for the storage of the skins while they are awaiting shipment.

PARASITES.

Informal discussion of the value to fox-farming operations of more information in regard to parasitism among foxes led to a request from the Biological Survey in 1918 that a collection of viscera of foxes and of other material for examination be made at the Pribilofs. The making of the collection was begun on St. George Island in December, 1918, and continued into 1919. Material was secured from 18 foxes, and in addition specimens of fox food were preserved.

Dr. B. H. Ransom, Chief, Zoological Division, Bureau of Animal Industry, rendered a report in February, 1920, based on a study of the collection, as follows:

> The intestines and other viscera from 18 blue foxes from St. George Island of the Pribilof Islands, killed or dying during the season of 1918–19, have been examined for parasites and the following findings noted:
>
> Ten of the foxes had tapeworms in the small intestine, the tapeworms being a species of the genus Mesocestoides, and apparently a new species, although this material is still being studied. These tapeworms were present as a rule in large numbers. The life history of the worms is not known, but from the distribution of the parasite it is surmised that the intermediate hosts are fishes. One of the foxes had one tapeworm head, the worm apparently belonging to the genus Taenia, but having only a part of one circle of hooks remaining on the head; this worm has not been identified, and

perhaps can not be identified on such a small amount of material in poor condition. Eight of the foxes were infested with ascarids, the large round worm of the small intestine, which is, at times, sufficiently numerous to cause serious damage. The damage due to ascarid worms is not only that which follows from their presence in the digestive tract but is also due, as recent investigations have shown, to injuries to the lungs occasioned by the passage of the larval ascarids from the blood stream to the air passages in the course of their migration through the body. One of the foxes had in the small intestine a number of dipterous larvæ which have not yet been identified. It is likely that these larvæ were not parasitic but were due to the fox having eaten some foodstuff, possibly meat, which had been flyblown.

In comment on the foregoing findings it may be said that a feature of considerable interest is the absence of any hookworms. Inasmuch as hookworm disease is one of the most serious pests to be met with in raising foxes or related carnivores, it appears that the island on which these foxes are being raised is a particularly favorable location from this standpoint. It would seem that conditions on the island are peculiarly unfavorable for maintaining a hookworm infection among foxes, or that the original stock placed on the island was fortunately free from hookworm. In any event it would appear to be worth while to take precautions to keep this island uninfested with hookworm either by not bringing in new stock which might be infected, or if new stock must be brought in by subjecting it first to careful fecal examination to ascertain the presence of hookworms, and the exclusion of infected animals until fecal examination following treatment had shown that the animals were free from infection.

Of the parasites already present in the foxes the ascarid is probably the most injurious, but this worm is readily removable by the use of oil of chenopodium accompanied by liberal doses of castor oil. The dose used for dogs is one-tenth of 1 mil of wormseed oil per kilo of weight of dog, or 1 mil of oil for a 22-pound dog followed immediately by an ounce of castor oil. The amount of damage due to the Mesocestoides is problematical. These tapeworms were present in very large numbers, in some instances forming a mass of worms which almost occlude the intestine. It is likely that these worms could be readily removed by treatment with oleoresin of male fern. The dose for dogs is 1 to 2 drams; for foxes it would be advisable to use smaller doses, perhaps 3 to 4 mils. Experiments indicate that contrary to what is sometimes said, the male fern may be followed immediately by an ounce of castor oil with good results.

An examination of the viscera other than the digestive tract does not disclose any parasites, nor was the seal meat, which was sent in as a sample of the food used by the foxes, found to be parasitized. The sea urchins were not examined, as we have no reason at present for believing that animals in this group need be suspected of being intermediate hosts or carriers of any sort for the parasites of foxes.

REINDEER.

The reindeer herds on St. Paul and St. George Islands maintained themselves in satisfactory condition during 1919. Limited use was made of them for furnishing food both for the natives and the Bureau's employees. The meat provides a welcome change of diet for all; it compares very favorably with beef.

A question having been raised as to the adequacy of the natural food supply on the islands for maintaining animals in larger numbers than already existed, the matter was looked into in some detail. It is now believed that no concern need be felt on this account for some years, even with the animals increasing considerably in numbers. For instance, it was found that there was an area of not less than 4 square miles on the eastern section of St. George Island covered with rich reindeer moss which had not been touched for months, if at all, during the season. Observations made on St. Paul Island indicate that the moss reproduces itself there much more rapidly than it does on the mainland of Alaska.

It is difficult to establish systematic methods of handling the reindeer on St. Paul and St. George Islands. The animals are wild and seldom approach within sight of the villages. To domesticate the

reindeer to an extent which would permit of their being driven to corrals at will, where selections could be made of animals to be killed and of those to be reserved for breeders, would require supervision and experience beyond present facilities. The herds, however, in their present status are very valuable; they yield a not inconsiderable amount of food and cost the Government nothing.

Owing to the wildness of the reindeer and the considerable expanse of territory over which they roam, the task of making even an approximately accurate count of them demands the suspension of other work to an extent which can not often be afforded. It was estimated that the herd on St. Paul Island at the end of the year 1919 consisted of 35 males and 129 females, a total of 164. Fourteen reindeer were killed on St. Paul for food in 1919. A rough census of the St. George herd was taken in March, 1919, with the following results: Males, 1 year old and over, 5; males, less than 1 year old, 19; females, 1 year old and over, 60; females, less than 1 year old, 27; a total of 111 animals. At the end of the year the herd numbered approximately 123, of which 18 were males and 105 females. Twenty-two reindeer were killed for food on St. George in the year 1919.

The totals of 164 for St. Paul and 123 for St. George give an aggregate of 287 reindeer on both islands at the end of the year 1919, a net increase of 18 over the corresponding total a year previous. In 1918, 20 were killed for food, and in 1919, 36.

PATROL OF NORTH PACIFIC OCEAN AND BERING SEA.

The Coast Guard cutters *Unalga* and *Bear* were on duty in the North Pacific Ocean and Bering Sea in the season of 1919.

The *Unalga* left San Francisco for the season's cruise April 20 and returned to that port October 30. In addition to other multitudinous duties of various kinds in the interests of the public welfare, the vessel rendered valuable service to the Bureau. Freight and mail were transported between Unalaska and the Pribilofs; employees were transported between St. Paul and St. George Islands; at St. Paul Island a quantity of salt was taken from the village to Northeast Point and a quantity of sealskins transported from Northeast Point to the village.

The *Bear* left Seattle for the season's cruise on May 15 and returned there November 10. From Seattle there were aboard as passengers four men employed by Funsten Bros. & Co., who were en route for the Pribilofs to assist in sealing operations. The *Bear* after arriving at Unalaska joined in the work of caring for the victims of influenza. In line with the precautions taken to prevent the introduction of that disease at the Pribilofs, it was deemed best that the vessel should not stop there on its way northward from Unalaska. The four passengers for the Pribilofs were accordingly taken to Nome where they later secured passage to Seattle on the *Victoria*. Southbound on October 20, the *Bear* called at St. Paul Island and took aboard one passenger and mail and freight for Seattle.

While pelagic-sealing operations in connection with the North American fur-seal herd have ceased, the presence of patrol vessels is necessary as a precautionary measure against the recurrence of illicit activities.

TRACTORS, TRAILERS, AND ROAD GRADER, ST. PAUL ISLAND.

The Bureau is pleased to make acknowledgment of the numerous courtesies extended by the Coast Guard in connection with Alaskan operations, and to express its appreciation of the earnest spirit of cooperation constantly manifested by the personnel of that service.

SEALING PRIVILEGES ACCORDED ABORIGINES.

A considerable number of fur-seal skins were taken in 1919 by Indians in connection with operations in the waters off the coast of Washington. The taking of the seals was in accordance with the privilege granted by the North Pacific Sealing Convention of July 7, 1911, and the act of Congress approved August 24, 1912, giving effect to that convention. In the matter of authenticating these skins, the Bureau had the assistance of Mr. A. D. Dodge, superintendent, U. S. Indian School, Neah Bay, Wash., and of Dr. Otis O. Benson, superintendent, Taholah Indian Agency, Taholah, Wash. Five hundred fifty-four skins were authenticated by Messrs. Dodge and Benson, all of which with one or two exceptions were secured in 1919. Of these skins 251 were from male seals and 303 from females.

SHIPMENTS OF SKINS FROM PRIBILOF ISLANDS IN 1919.

Fur-seal skins.—There were two shipments of commercial fur-seal skins from the Pribilof Islands in 1919. The first was on the *Saturn* and consisted of 106 casks containing 3,624 skins from St. Paul Island and 14 casks containing 389 skins from St. George Island, a total of 4,013 skins. The St. Paul skins were placed aboard the *Saturn* on May 21 and the St. George skins on May 6. The *Saturn* left the islands May 22. The skins reached San Francisco June 5 and were shipped from there June 6 via Southern Pacific to Ogden, Union Pacific to Kansas City, and Wabash to St. Louis. They arrived at St. Louis June 18.

The second shipment was made on the *Nanshan* and consisted of 863 casks containing 22,829 skins from St. Paul Island and 131 casks containing 3,356 skins from St. George Island, a total of 26,185 skins. The St. George skins were placed aboard the *Nanshan* on September 30 and the St. Paul skins about the same time. The *Nanshan* left the islands October 13 and arrived at Seattle October 26. Thirty-seven barrels of skins were shipped from Seattle to St. Louis by express, this being done at the request of Funsten Bros. & Co. to insure more prompt delivery of raw material to keep the dressing and dyeing plant in operation without interruption. The company paid the difference in cost of shipment by express over that by freight. The remaining 957 barrels were shipped to St. Louis by freight in four cars via Northern Pacific to Minnesota Transfer and Chicago, Burlington & Quincy to St. Louis.

In addition to the commercial skins shipped from the Pribilofs in 1919, there were also shipped on the *Nanshan* 19 specimen skins for the California Academy of Sciences. Three of these were from St. Paul Island and 16 from St. George Island.

Fox skins.—The fox skins taken in the season of 1918–19 were shipped on the *Saturn* in May. The shipment consisted of 119 blue fox skins and 25 white fox skins from St. Paul Island, and 548 blue fox skins and 5 white fox skins from St. George Island, a total of 697 skins. The skins were shipped to St. Louis by express from San Francisco June 5.

SALES OF FUR-SEAL SKINS.

The fur-seal skins sold by the Department of Commerce in the calendar year 1919 were disposed of at St. Louis by public auction through the Department's agents, Funsten Bros. & Co. Two sales were held. April 28 and September 10, respectively. The total number of Pribilof Islands skins sold was 19,157 and the total price bid was $1,501,603.50. All had been dressed, dyed, and machined before being offered for sale.

At the sale on April 28 there were also sold eight other fur-seal skins which had been confiscated by the Bureau. These eight skins, dressed, dyed, and machined, sold for $75 each, or $600 for the lot. These skins are not included in the detailed statement in respect to the sale of April 28.

At the sale on April 28, there were sold 10,102 skins from the Pribilofs. The total price bid was $674,491. The maximum price was $85 per skin; the average price was $66.77 per skin, an advance of 29 per cent over the average of $51.72 received the last preceding sale, October 7, 1918, and an advance of 50 per cent over the average of $44.58 received at the sale on April 22, 1918.

At the sale on September 10, 1919, there were sold 9,055 skins from the Pribilof Islands. The total price bid was $827,112.50. The maximum price was $115 per skin; the average price was $91.34 per skin, an advance of 37 per cent over the average of $66.77 received at the last preceding sale, April 28, 1919, and an advance of 77 per cent over the average of $51.72 received at the sale on October 7, 1918. The following tables give details and summaries in regard to the sales:

Sales of Dressed, Dyed, and Machined Pribilof Fur-Seal Skins at St. Louis, 1919.

SALE OF 10,102 SKINS, ST. LOUIS, APR. 28, 1919.

Lot No.	Number of skins.	Trade classification.	Price per skin.	Total for lot.
1	50	Wigs	$81.00	$4,050.00
2	50	do	81.00	4,050.00
3	50	do	80.00	4,000.00
4	50	do	82.00	4,100.00
5	50	do	81.00	4,050.00
6	50	do	85.00	4,250.00
7	50	do	82.00	4,100.00
8	50	do	84.00	4,200.00
9	50	do	84.00	4,200.00
10	50	do	83.00	4,150.00
11	50	do	88.00	4,400.00
12	50	Wigs; cut, scarred, etc	60.00	3,000.00
13	50	do	60.00	3,000.00
14	50	do	62.00	3,100.00
15	60	Extra extra large	79.00	4,740.00
16	60	do	77.00	4,620.00
17	60	do	78.00	4,680.00
18	60	do	76.00	4,560.00
19	60	do	76.00	4,560.00
20	60	do	76.00	4,560.00
21	60	do	78.00	4,680.00
22	60	do	79.00	4,740.00
23	60	do	77.50	4,650.00
24	60	do	76.50	4,590.00
25	60	do	80.00	4,800.00
26	60	do	76.00	4,560.00
27	60	do	77.50	4,650.00
28	60	Extra extra large	$75.00	$4,500.00
29	60	do	77.00	4,620.00
30	60	do	74.00	4,440.00
31	60	do	77.00	4,620.00
32	60	do	75.00	4,500.00
33	60	do	75.00	4,500.00
34	60	do	76.00	4,560.00
35	60	do	78.00	4,680.00
36	60	do	75.00	4,500.00
37	60	do	75.00	4,500.00
38	60	do	75.00	4,500.00
39	60	do	74.00	4,440.00
40	60	do	79.00	4,740.00
41	60	Extra extra large; cut, scarred, etc	59.00	3,540.00
42	60	do	57.00	3,420.00
43	60	do	58.00	3,480.00
44	60	do	61.00	3,660.00
45	50	do	62.00	3,100.00
46	70	Extra large	73.00	5,110.00
47	70	do	74.00	5,180.00
48	70	do	76.00	5,320.00
49	70	do	74.00	5,180.00
50	70	do	74.50	5,215.00
51	70	do	75.00	5,250.00
52	70	do	76.00	5,320.00
53	70	do	79.00	5,530.00
54	70	do	77.00	5,390.00

Sale of Dressed, Dyed, and Machined Pribilof Fur-Seal Skins at St. Louis, 1919—Continued.

SALE OF 10,102 SKINS, ST. LOUIS, APR. 28, 1919—Continued.

Lot No.	Number of skins.	Trade classification.	Price per skin.	Total for lot.
55	70	Extra large	$78.00	$5,460.00
56	70	do	75.00	5,250.00
57	70	do	77.00	5,390.00
58	70	do	78.00	5,460.00
59	70	do	77.00	5,390.00
60	70	do	78.00	5,460.00
61	50	do	77.00	3,850.00
62	45	do	77.00	3,465.00
63	70	Extra large; cut, scarred, etc	63.00	4,410.00
64	70	do	65.00	4,550.00
65	70	do	65.00	4,550.00
66	80	Large	74.00	5,920.00
67	80	do	74.00	5,920.00
68	80	do	80.00	6,400.00
69	80	do	77.00	6,160.00
70	80	do	77.00	6,160.00
71	80	do	77.00	6,160.00
72	80	do	77.50	6,200.00
73	80	do	78.50	6,280.00
74	80	do	79.50	6,360.00
75	80	do	78.00	6,240.00
76	80	do	80.00	6,400.00
77	80	do	83.00	6,640.00
78	80	do	81.00	6,480.00
79	50	do	79.00	3,950.00
80	80	Large; cut, scarred, etc	60.00	4,800.00
81	80	do	64.00	5,120.00
82	80	do	65.00	5,200.00
83	90	Mediums	69.00	6,210.00
84	90	do	70.50	6,345.00
85	90	do	70.00	6,300.00
86	90	do	75.00	6,750.00
87	90	do	73.00	6,570.00
88	90	do	73.00	6,570.00
89	90	Mediums; cut, scarred, etc	56.00	5,040.00
90	90	do	58.00	5,220.00
91	50	Small mediums	60.00	3,000.00
92	50	III wigs	51.00	2,550.00
93	55	III extra extra large	53.00	2,915.00
94	45	III extra large	48.00	2,160.00
95	65	III—47 large, 16 mediums, 2 small mediums	49.00	3,185.00
101	45	Wigs	79.00	3,555.00
102	45	do	77.00	3,465.00
103	45	do	78.00	3,510.00
104	45	do	77.00	3,465.00
105	45	Wigs; cut, scarred, etc	57.00	2,565.00
106	43	do	62.00	2,666.00
107	55	Extra extra large	70.00	3,850.00
108	55	do	69.00	3,795.00
109	55	do	68.00	3,740.00
110	55	do	69.00	3,795.00
111	55	do	70.50	3,877.50
112	40	Extra extra large	$70.50	$2,820.00
113	55	Extra extra large; cut, scarred, etc	69.50	3,822.50
114	48	do	63.00	3,024.00
115	70	Extra large	68.00	4,760.00
116	70	do	66.50	4,655.00
117	70	do	70.50	4,935.00
118	70	do	70.00	4,900.00
119	70	do	70.00	4,900.00
120	70	do	70.00	4,900.00
121	32	do	72.00	2,304.00
122	70	Extra large; cut, scarred, etc	55.50	3,885.00
123	70	do	55.50	3,885.00
124	24	do	55.50	1,332.00
125	80	Large	61.00	4,880.00
126	80	do	59.50	4,760.00
127	80	do	62.00	4,960.00
128	80	do	70.00	5,600.00
129	80	do	69.00	5,520.00
130	80	do	69.00	5,520.00
131	80	do	68.00	5,440.00
132	80	do	69.00	5,520.00
133	50	do	67.00	3,350.00
134	45	do	70.00	3,150.00
135	80	Large; cut, scarred, etc	55.00	4,400.00
136	80	do	50.00	4,000.00
137	80	do	50.50	4,040.00
138	90	Mediums	60.00	5,400.00
139	90	do	63.00	5,670.00
140	90	do	62.00	5,580.00
141	90	do	61.00	5,490.00
142	90	do	58.50	5,265.00
143	90	do	61.00	5,490.00
144	51	do	59.00	3,009.00
145	90	Mediums; cut, scarred, etc	40.00	3,600.00
146	90	do	37.00	3,330.00
147	90	do	39.00	3,510.00
148	66	do	40.00	2,640.00
149	94	Small mediums	50.00	4,700.00
150	74	Small mediums; cut, scarred, etc	28.00	2,072.00
151	57	III—43 wigs, 14 extra extra large	39.00	2,223.00
152	48	III extra large	40.00	1,920.00
153	79	III large	30.00	2,370.00
154	87	III mediums	27.50	2,392.50
155	85	do	27.50	2,337.50
156	71	III small mediums	23.00	1,633.00
157	26	IV—6 wigs, 2 extra large, 3 extra large, 15 large	18.00	468.00
158	57	IV—24 mediums, 33 small mediums	10.00	570.00
	10,102			674,491.00

SALE OF 9,055 SKINS, ST. LOUIS, SEPT. 10, 1919.

Lot No.	Number of skins.	Trade classification.	Price per skin.	Total for lot.
1	50	Wigs	$97.00	$4,850.00
2	50	do	101.00	5,050.00
3	50	do	100.00	5,000.00
4	50	do	101.00	5,050.00
5	50	do	103.00	5,150.00
6	50	do	105.00	5,250.00
7	50	do	102.00	5,100.00
8	50	do	104.00	5,200.00
9	50	do	106.00	5,300.00
10	50	do	105.00	5,250.00
11	50	do	115.00	5,750.00
12	35	do	107.50	3,762.50
13	50	Wigs; cut, scarred, etc	74.00	3,700.00
14	50	do	77.00	3,850.00
15	60	Extra extra large	$105.00	$6,300.00
16	60	do	104.00	6,240.00
17	60	do	105.00	6,300.00
18	60	do	107.50	6,450.00
19	60	do	104.00	6,240.00
20	60	do	110.00	6,600.00
21	60	do	109.00	6,540.00
22	60	do	107.00	6,420.00
23	60	do	107.00	6,420.00
24	60	do	106.00	6,360.00
25	60	do	109.00	6,540.00
26	60	do	106.00	6,360.00
27	60	do	110.00	6,600.00
28	60	do	108.00	6,480.00
29	60	do	111.00	6,660.00

SALE OF DRESSED, DYED, AND MACHINED PRIBILOF FUR-SEAL SKINS AT ST. LOUIS, 1919—Continued.

SALE OF 9,055 SKINS, ST. LOUIS, SEPT. 10, 1919—Continued.

Lot No.	Number of skins.	Trade classification.	Price per skin.	Total for lot.
30	60	Extra extra large	$111.00	$6,660.00
31	60	do	112.00	6,720.00
32	60	do	111.00	6,660.00
33	60	do	110.00	6,600.00
34	60	do	112.00	6,720.00
35	60	do	115.00	6,900.00
36	60	Extra extra large; cut, scarred, etc.	97.00	5,820.00
37	60	do	95.00	5,700.00
38	60	do	95.00	5,700.00
39	70	Extra large	100.00	7,000.00
40	70	do	99.00	6,930.00
41	70	do	98.00	6,860.00
42	70	do	101.00	7,070.00
43	70	do	102.00	7,140.00
44	70	do	99.00	6,930.00
45	70	do	96.00	6,720.00
46	70	do	104.00	7,280.00
47	70	do	99.00	6,930.00
48	70	do	99.00	6,930.00
49	70	do	101.00	7,070.00
50	70	do	104.00	7,280.00
51	70	do	101.00	7,070.00
52	70	do	109.00	7,630.00
53	70	do	104.50	7,315.00
54	70	do	105.00	7,350.00
55	70	do	107.00	7,490.00
56	70	Extra large; cut, scarred, etc	95.00	6,650.00
57	70	do	87.00	6,090.00
58	50	do	95.00	4,750.00
59	80	Large	101.00	8,080.00
60	80	do	100.00	8,000.00
61	80	do	101.00	8,080.00
62	80	do	100.00	8,000.00
63	80	do	100.00	8,000.00
64	80	do	103.00	8,240.00
65	80	do	100.00	8,000.00
66	80	do	100.00	8,000.00
67	80	do	99.00	7,920.00
68	80	do	105.00	8,400.00
69	80	do	104.00	8,320.00
70	80	do	102.00	8,160.00
71	80	do	101.00	8,080.00
72	80	do	101.00	8,080.00
73	80	do	100.00	8,000.00
74	80	do	100.00	8,000.00
75	80	do	101.00	8,080.00
76	80	do	103.00	8,240.00
77	80	do	100.00	8,000.00
78	80	do	102.50	8,200.00
79	80	do	101.00	8,080.00
80	80	do	102.00	8,160.00
81	80	do	102.00	8,160.00
82	80	Large; cut, scarred, etc	79.00	6,320.00
83	80	do	81.00	6,480.00
84	80	Large; cut, scarred, etc	$80.00	$6,400.00
85	80	do	78.00	6,240.00
86	80	do	80.00	6,400.00
87	80	do	82.00	6,560.00
88	90	Mediums	90.00	8,100.00
89	90	do	85.00	7,650.00
90	90	do	85.00	7,650.00
91	90	do	82.00	7,380.00
92	90	do	82.50	7,425.00
93	90	do	82.00	7,380.00
94	90	do	82.00	7,380.00
95	90	do	83.00	7,470.00
96	90	do	83.00	7,470.00
97	90	do	83.00	7,470.00
98	90	do	83.50	7,515.00
99	90	do	83.00	7,470.00
100	90	do	87.00	7,830.00
101	90	do	85.00	7,650.00
102	90	do	83.00	7,470.00
103	90	do	83.00	7,470.00
104	90	do	86.00	7,740.00
105	90	do	84.00	7,560.00
106	90	do	82.00	7,380.00
107	90	do	85.00	7,650.00
108	80	do	83.00	6,640.00
109	80	do	86.00	6,880.00
110	90	Mediums; cut, scarred, etc	62.00	5,580.00
111	90	do	65.00	5,850.00
112	90	do	67.00	6,030.00
113	90	do	66.00	5,940.00
114	90	do	66.00	5,940.00
115	60	do	65.00	3,900.00
116	90	Small mediums	66.00	5,940.00
117	90	do	68.00	6,120.00
118	90	do	69.00	6,210.00
119	80	do	66.50	5,320.00
120	70	Small mediums; cut, scarred, etc.	50.00	3,500.00
121	65	do	50.00	3,250.00
122	50	III wigs	57.00	2,850.00
123	65	III—40 extra extra large, 25 extra large	61.00	3,965.00
124	55	III large	52.00	2,860.00
125	75	III—39 mediums, 36 small mediums	42.00	3,150.00
126	30	IV—8 wigs, 3 extra extra large, 4 extra large, 10 large, 4 mediums, 1 small medium	22.00	660.00
	9,055			$827,112.50

SUMMARY OF TRADE CLASSIFICATIONS, OF PERCENTAGES OF TOTAL IN EACH CLASS, AND OF AMOUNTS RECEIVED AT SALES OF FUR-SEAL SKINS, ST. LOUIS, 1919.

Trade classification.	Sale, Apr. 28, 1919.			Sale, Sept. 10, 1919.			Total.	
	Number.	*Per cent.*	*Amount.*	*Number.*	*Per cent.*	*Amount.*	*Number.*	*Amount.*
Wigs	1,067	10.56	$78,211.00	743	8.21	$71,288.50	1,810	$149,499.50
Extra extra large	2,339	23.16	168,911.00	1,483	16.38	156,496.00	3,822	325,407.00
Extra large	2,067	20.46	145,320.00	1,409	15.56	140,098.00	3,476	285,418.00
Large	2,446	24.21	166,473.00	2,385	26.34	227,760.00	4,831	394,233.00
Mediums	1,859	18.40	103,743.00	2,513	27.75	199,596.00	4,372	303,339.00
Small mediums	324	3.21	11,833.00	522	5.76	31,874.00	846	43,707.00
Total	10,102	100.00	674,491.00	9,055	100.00	827,112.50	19,157	1,501,603.50

GRADES AND COMPARATIVE VALUES OF SEALSKINS.

As was done in the 1918 Alaska report in respect to the sealskins sold in 1918, record is made of the comparative trade classifications and prices obtained for the various sizes of sealskins sold in 1919. The following table gives the number and grade of skins of each category and the high, low, and average prices received:

COMPARATIVE VALUES BY GRADES AND SIZES OF SEALSKINS SOLD IN 1919.

Classes and sales.	Grade.	Number.	High.	Low.	Average.	Total.	Total number.	Average.	Total price.
Wigs:									
Apr. 28	I and II.	730	$85.00	$77.00	$81.57	$59,545.00	1,067	$73.30	$78,211.00
	Cut, etc.	238	62.00	57.00	60.21	14,331.00			
	III	93	51.00	39.00	45.45	4,227.00			
	IV	6	18.00	18.00	18.00	108.00			
Sept. 10	I and II.	585	115.00	97.00	103.78	60,712.50	743	95.95	71,288.50
	Cut, etc.	100	77.00	74.00	75.50	7,550.00			
	III	50	57.00	57.00	57.00	2,850.00			
	IV	8	22.00	22.00	22.00	176.00			
Extra extra large:									
Apr. 28	I and II.	1,875	80.00	68.00	75.40	141,367.50	2,339	72.22	168,911.00
	Cut, etc.	393	69.50	57.00	61.19	24,046.50			
	III	69	53.00	39.00	50.16	3,461.00			
	IV	2	18.00	18.00	18.00	36.00			
Sept. 10	I and II.	1,260	115.00	104.00	108.55	136,770.00	1,483	105.53	156,496.00
	Cut, etc.	180	97.00	95.00	95.67	17,220.00			
	III	40	61.00	61.00	61.00	2,440.00			
	IV	3	22.00	22.00	22.00	66.00			
Extra large:									
Apr. 28	I and II.	1,597	79.00	66.50	74.25	118,574.00	2,067	70.30	145,320.00
	Cut, etc.	374	65.00	55.50	60.46	22,612.00			
	III	93	48.00	40.00	43.87	4,080.00			
	IV	3	18.00	18.00	18.00	54.00			
Sept. 10	I and II.	1,190	109.00	96.00	101.68	120,995.00	1,409	99.43	140,098.00
	Cut, etc.	190	95.00	87.00	92.05	17,490.00			
	III	25	61.00	61.00	61.00	1,525.00			
	IV	4	22.00	22.00	22.00	88.00			
Large:									
Apr. 28	I and II.	1,825	83.00	59.50	73.41	133,970.00	2,446	68.06	166,473.00
	Cut, etc.	480	65.00	50.00	57.42	27,560.00			
	III	126	49.00	30.00	37.09	4,673.00			
	IV	15	18.00	18.00	18.00	270.00			
Sept. 10	I and II.	1,840	105.00	99.00	101.24	186,280.00	2,385	95.50	227,760.00
	Cut, etc.	480	82.00	78.00	80.00	38,400.00			
	III	55	52.00	52.00	52.00	2,860.00			
	IV	10	22.00	22.00	22.00	220.00			
Mediums:									
Apr. 28	I and II.	1,131	75.00	58.50	66.00	74,649.00	1,859	55.81	103,743.00
	Cut, etc.	516	58.00	37.00	45.23	23,340.00			
	III	188	49.00	27.50	29.33	5,514.00			
	IV	24	10.00	10.00	10.00	240.00			
Sept. 10	I and II.	1,960	90.00	82.00	83.99	164,630.00	2,513	79.43	199,596.00
	Cut, etc.	510	67.00	62.00	65.18	33,240.00			
	III	39	42.00	42.00	42.00	1,638.00			
	IV	4	22.00	22.00	22.00	88.00			
Small mediums:									
Apr. 28	I and II.	144	60.00	50.00	53.47	7,700.00	324	36.52	11,833.00
	Cut, etc.	74	28.00	28.00	28.00	2,072.00			
	III	73	49.00	23.00	23.71	1,731.00			
	IV	33	10.00	10.00	10.00	330.00			
Sept. 10	I and II.	350	69.00	66.00	67.40	23,590.00	522	61.06	31,874.00
	Cut, etc.	135	50.00	50.00	50.00	6,750.00			
	III	36	42.00	42.00	42.00	1,512.00			
	IV	1	22.00	22.00	22.00	22.00			
Apr. 28							10,102	66.77	674,491.00
Sept. 10							9,055	91.34	827,112.50
Both sales							19,157	78.38	1,501,603.50

SUMMARY OF FUR-SEAL SKINS SHIPPED TO FUNSTEN BROS. & CO.

Beginning with the year 1913 all merchantable fur-seal skins shipped from the Pribilof Islands have been forwarded to Funsten Bros. & Co., St. Louis, Mo., for sale. The first sale, held in December, 1913, consisted of 1,896 salted skins. All subsequent sales have been of dressed, dyed, and machined skins. The table following records all shipments made to the firm in the years 1913 to 1919, inclusive, sales of skins, and balances remaining in the custody of the firm.

SUMMARY OF PRIBILOF ISLANDS FUR-SEAL SKINS RECEIVED AND SOLD BY FUNSTEN BROS. & CO., ST. LOUIS, MO., AND BALANCES IN FIRM'S CUSTODY, 1913 TO 1919.

Receipts					Sales.				Balances on hand.		
Approximate date of shipment from Pribilofs.	Approximate date of receipt by firm.	Number of skins.			Date of sale.	Number of skins.			Food skins.[a]	Commercial skins.[b]	Total.
		Food skins.[a]	Commercial skins.[b]	Total.		Food skins.[a]	Commercial skins.[b]	Total.			
Aug. 8, 1913	1913	2,296		2,296					2,296		2,296
					Dec. 16, 1913	1,896		1,896	400		400
Oct., 1914	1914	2,884		2,884					3,284		3,284
1914	1915	12		12					3,296		3,296
Sept., 1915	1915	3,000		3,000					6,296		6,296
					Sept. 20, 1916	1,900		1,900	4,396		4,396
Oct., 1916	Nov. 14, 1916	7,061		7,061					11,457		11,457
					Jan. 29, 1917	2,000		2,000	9,457		9,457
					Apr. 18, 1917	1,500		1,500	7,957		7,957
Aug. 1, 1917	Sept. 19, 1917	4,882		4,882					12,839		12,839
					Oct. 8, 1917	3,239		3,239	9,600		9,600
Dec. 17, 1917	Feb., 1918	2,427	1,831	4,258					12,027	1,831	13,858
					Apr. 22, 1918	6,100		6,100	5,927	1,831	7,758
June 22, 1918	July 30, 1918		3,542	3,542					5,927	5,373	17,300
					Oct. 7, 1918	2,000		2,000	3,927	5,373	91,300
Sept. 14, 1918	Oct. 30, 1918		17,816	17,816					3,927	23,189	27,116
Oct. 6, 1918	Nov. 25, 1918		1,978	1,978					3,927	25,167	29,094
Dec. 12, 1918	Jan. 29, 1919		7,482	7,482					3,927	32,649	36,576
					Apr. 28, 1919	3,882	6,220	10,102	45	26,429	26,474
May 21, 1919	June 24, 1919		4,013	4,013					45	30,442	30,487
					Sept. 10, 1919		9,055	9,055	45	21,387	21,432
Oct. 13, 1919	Nov. 24, 1919		26,185	26,185					c 43	47,572	47,615

a Skins taken from seals killed for natives' food prior to the termination on Aug. 24, 1917, of the 5-year period of restricted killings provided by the act of Aug. 24, 1912.
b Skins taken subsequent to Aug. 24, 1917.
c Final count of food skins at St. Louis showed 2 less than the Bureau's former record. The St. Louis count was accepted by the Bureau in accordance with letter of Jan. 24, 1920, to Funsten Bros. & Co.

FUR-SEAL SKINS ON HAND DECEMBER 31, 1919.

In order to have available in concise form figures in regard to the number of fur-seal skins handled during the year and the number on hand both at the Pribilof Islands and at St. Louis at the end of the calendar year 1919, the following tabulations have been prepared:

St. Louis Record of Sealskins.[a]

On hand Jan. 1, 1919		29,080
Shipments received in 1919:		
January	7,482	
June	4,013	
July (from Washington)	12	
November	26,185	
		37,692
Total		66,772
Sales during 1919:		
April	10,102	
September	9,055	
		19,157
Balance on hand Dec. 31, 1919		47,615

Pribilof Record of Sealskins.[a]

On hand Jan. 1, 1919:		
St. Paul Island	3,796	
St. George Island	389	
En route (on board *Roosevelt*)	7,482	
		11,667
Skins taken in 1919:		
St. Paul Island	24,053	
St. George Island	3,768	
		27,821
Total		39,488
Shipments during 1919:		
St. Paul Island	29,352	
St. George Island	8,328	
		37,680
Balance on hand Dec. 31, 1919 (St. Paul, 1,405; St. George, 412)		[b] 1,817
Grand total on hand Dec. 31, 1919		49,432

SALE OF FOX SKINS.

The fox skins taken on the Pribilof Islands in the season of 1918–19 numbered 667 blue pelts and 30 white pelts, which, with the exception of 2 blue pelts withheld for exhibition purposes at Washington, were sold at public auction at St. Louis on September 10, 1919. The 665 blues brought $130,274.50, an average of $195.90 each, and the 30 white skins $1,660, an average of $55.33 each. The following table shows details in regard to the sale:

[a] When the shipment en route from the islands at the end of 1918 was checked out at St. Louis the number of skins was found to be 7,482 instead of 7,483, as stated on p. 114 of the corresponding report for 1918. It was also found when skins were packed on St. George Island in 1919 that 389 skins remained from the 1918 take, instead of 387, as stated on p. 109 of the printed report for 1918.

[b] A report from the agent and caretaker on St. Paul Island, dated Dec. 8, 1919, stated that counts of the skins on hand showed an excess of 9 over the number supposed to remain after all shipments. The shipment which reached the dressing and dyeing plant in November, 1919, had not been unpacked and checked at the end of the year, and part or all of this excess may be accounted for when final report is made on that shipment. In handling the large number of skins taken during the season, it seems practically impossible to avoid the occurrence of slight discrepancies in the counts.

DETAILS OF SALE OF 665 BLUE FOX SKINS AND 30 WHITE FOX SKINS FROM PRIBILOF ISLANDS AT ST. LOUIS, SEPT. 10, 1919.

Lot No.	Number of skins.	Trade classification.	Price per skin.	Total for lot.
Blue fox skins:				
300	4	Extra extra fine	$350.00	$1,400.00
301	4	do	310.00	1,240.00
302	4	Extra fine	315.00	1,260.00
303	4	do	320.00	1,280.00
304	4	do	275.00	1,100.00
305	6	do	370.00	2,220.00
306	6	do	325.00	1,950.00
307	5	Extra large fine	335.00	1,675.00
308	10	II extra large dark	220.00	2,200.00
309	6	I extra large dark	300.00	1,800.00
310	8	do	265.00	2,120.00
311	8	do	265.00	2,120.00
312	10	I dark	295.00	2,950.00
313	10	do	260.00	2,600.00
314	10	II extra large dark	225.00	2,250.00
315	10	do	210.00	2,100.00
316	12	II dark	190.00	2,280.00
317	12	do	190.00	2,280.00
318	10	II extra large dark low	145.00	1,450.00
319	8	do	125.00	1,000.00
320	16	II dark low	100.00	1,600.00
321	9	I extra large blue	190.00	1,710.00
322	10	I blue	205.00	2,050.00
323	10	II extra large blue	215.00	2,150.00
324	10	do	195.00	1,950.00
325	10	II blue	190.00	1,900.00
326	10	do	135.00	1,350.00
327	10	II extra large blue low	110.00	1,100.00
328	10	do	110.00	1,100.00
329	10	II blue low	85.00	850.00
330	8	Dark silvery	395.00	3,160.00
331	15	III dark	47.00	705.00
332	6	Extra large fine dark	380.00	2,280.00
333	4	Extra fine dark	325.00	1,300.00
334	4	do	320.00	1,280.00
335	8	II extra large fine dark	275.00	2,200.00
336	4	II large fine dark	215.00	860.00
337	6	I extra large fine dark	275.00	1,650.00
338	8	I fine dark	285.00	2,280.00
339	8	do	280.00	2,240.00
340	8	do	250.00	2,000.00
341	6	do	240.00	1,440.00
342	10	II fine dark	205.00	2,050.00
343	6	I extra large dark	220.00	1,320.00
344	5	do	215.00	1,075.00
345	8	II extra large dark	180.00	1,440.00
346	8	do	170.00	1,360.00
347	10	I dark	230.00	2,300.00
348	12	do	210.00	2,520.00
349	12	II dark	190.00	2,280.00
350	12	do	185.00	2,220.00
351	12	do	205.00	2,460.00
352	13	do	175.00	2,275.00
353	12	I blue	210.00	2,520.00
354	14	II extra large blue	160.00	2,240.00
355	10	II blue	160.00	1,600.00
356	10	do	155.00	1,550.00
357	7	do	130.00	910.00
358	12	II blue low	115.00	1,380.00
359	10	do	105.00	1,050.00
360	8	I extra large silvery	270.00	2,160.00
361	7	II silvery	205.00	1,435.00
362	11	I and II pale	175.00	1,925.00
363	17	III blue	60.00	1,020.00
364	21	IV	28.00	588.00
365	13	V	5.50	71.50
366	4	I fine dark	400.00	1,600.00
367	8	II fine dark	260.00	2,080.00
368	6	I dark	280.00	1,680.00
369	8	I blue	200.00	1,600.00
370	12	II blue	205.00	2,460.00
371	8	II blue low	160.00	1,280.00
372	11	I and II dark silvery	335.00	3,685.00
373	5	I silvery	230.00	1,150.00
373A	2	II extra large fine dark	280.00	560.00
White fox skins:				
374	16	I	67.00	1,072.00
375	14	II Pt. low	42.00	588.00
Total	695			131,934.50

JAPANESE SEALSKINS DELIVERED TO UNITED STATES.

The North Pacific Sealing Convention of July 7, 1911, provides that in respect to fur-seal skins taken annually upon Robben Island, or any other islands or shores of the waters covered by the convention subject to the jurisdiction of Japan, 10 per cent in number and value shall be delivered to the United States. In 1918 the Japanese take consisted of 555 skins. The same number were taken in 1919. The share of the United States for the two years was, accordingly, 111 skins. These skins were forwarded to the Bureau's agents, Funsten Bros. & Co., St. Louis, for sale. They arrived at St. Louis, March 15, 1920. Examination of the skins showed that they had been very carefully taken and cured. It is understood that the take of Japanese skins in 1918 and 1919 all came from Robben Island.

Information received informally from Mr. K. Ishino, of the Imperial Bureau of Fisheries of Japan, indicates that there were on Robben Island in 1919, between 11,000 and 12,000 seals, and that the seals on the Kuril Islands have gradually decreased in the past four or five years and have now almost disappeared. Mr. Ishino also stated that when at the Commander Islands in 1916 he determined that the Russian herd numbered about 50,000 animals. The Russian Government's report, however, claims only 30,000. In 1917 there were 800 seals killed on Copper Island, one of the Commander group. Mr. Ishino stated that sea otters are increasing among the Kuril Islands and that in 1919 he saw 300 and has reason to believe that there are at least 500 there. He advised also that sea otters are increasing about the Russian islands.

FUR-SEAL CENSUS, PRIBILOF ISLANDS, 1919.

By G. Dallas Hanna.

A census of the Alaska fur-seal herd was taken during the summer of 1919 by employing the methods which have been in practice for several previous years. These, together with the habits of the animals and the history of the herd have been fully described in the annual reports from 1914 to 1918, so that in order to avoid needless repetition these subjects will not be treated herein, except in so far as seems necessary to properly present the new data. Some new facts in regard to the natural history of the animals, learned in 1919, will be mentioned, however, in order to keep this phase of the subject up to date.

A complete count of bulls was made at the height of the breeding season. To facilitate the count, driftwood and paint markers were placed on some of the rookeries which are more difficult to count. While these were very helpful they only emphasized the need of permanent work of this character carried on with the erection of overhead observation positions.

After the breaking up of the harems, pups were counted on as many rookeries as possible in order to determine the average harem.

Preliminary harem counts (not tabulated herein) were made on St. George Island by C. E. Crompton and on St. Paul by the author. These proved helpful in the final counts and afforded a fair check on the work.

In the harem counts, H. D. Aller assisted on St. Paul and C. E. Crompton on St. George. The same men assisted in the pup counts on the same islands. Besides this Mr. Crompton made the pup count of Staraya Artil Rookery on St. George and Mr. Aller counted Polovina Cliffs Rookery on St. Paul.

DIFFICULTIES ENCOUNTERED.

As the seal herd grows a census taken by present means becomes less and less accurate. This is necessarily the case because of the large masses of animals dealt with, and unless an elaborate system of markers and elevated viewpoints be established it will not be many years until the count of harems will give no more accurate an enumeration than an estimation by the area method. The construction of the necessary apparatus, however, is believed to be feasible, and in view of the accurate knowledge which can be gained in regard to the state of the herd it would seem to be very profitable. Under present methods of calculation the harem count is fundamental. If it be far wrong the entire census becomes an estimate with figures which look mathematically exact. When the herd was small the harems could be counted exactly, but this is not true to-day. Therefore the readers of this report should bear in mind that although figures for the different classes are given exactly, only round numbers are intended. A complete census is an absolute impossibility. A close approximation to

the truth is all that can be expected. The best census is a very careful estimate made by utilizing as many of the known factors in the biology of the species as possible.

The great difficulty in counting bulls is to find a point back of the large rookeries from which all the animals can be seen. In order to overcome the trouble we climb a high ladder which can be moved from place to place, and whenever the weather and sea will permit boats are utilized, because of the better view thus usually secured. But both of these methods are unsatisfactory and certain construction work has been outlined elsewhere. Possibly the work could be done with absolute accuracy from an airplane with the aid of photography, a means first suggested, it is thought, by Dr. Paul Bartsch, of the United States National Museum.

With the decrease in the number of bulls and the increase in the average harem in 1919 less difficulty was experienced in counting pups than in 1917 and 1918. The rookeries are so large on St. Paul now, however, that a complete pup count could hardly be attempted without a considerable force of men. And even then it is believed the loss which the herd would suffer from the count would not be warranted. If the persons intrusted with the census work can give the subject their undivided attention during the season the count of pups on a few of the smaller rookeries should suffice to establish the average harem, provided, of course, that the harem count be accurate.

SUGGESTIONS FOR FUTURE CENSUSES.

In connection with work on the fur-seal rookeries it is impossible to forecast even one year in advance the new problems which may be forthcoming and the difficulties which may arise to interfere with a satisfactory taking of the census. However, several years' experience have led to certain conclusions which may be worth recording for such use as future workers may care to make of them.

It is anticipated that the bull counts on St. George Island can be made with comparative ease at the height of the breeding season; no material increase in the idle and harem bull classes is expected for at least two or three years. Staraya Artil and North Rookeries are much more satisfactorily counted from a boat than from the land side if the weather is suitable for one to get out on the sea. Should it be necessary to count from the land however, the use of a long ladder is recommended in order to permit observation of the entire areas of the breeding masses. East Reef and East Cliffs Rookeries can be seen better from the water, but satisfactory counts can be obtained from the land. A considerable risk is run in the case of the latter rookery on account of the dense vegetation growing on a ragged slope. Should one slip here he would fall among the bulls and be in imminent danger of losing his life. However, should timidity be felt regarding the cliff, it seems entirely feasible for the person doing the counting to be supported from above with a rope. Zapadni Rookery can be counted by exercising the ordinary care one acquires in creeping upon the breeding rookeries; and the same is true in the case of South.

The much larger areas on St. Paul Island, however, can not be disposed of so easily. There is not likely to be any material diminution in the numbers of bulls, which are a constant menace to observers

during the height of the season counts. While this is the most important of all census work it is becoming less and less satisfactory because of extraordinary difficulties encountered. The larger rookeries can not be seen from a point on the land side. Heretofore the precarious utilization of a long ladder supported by guys has been resorted to. These guys must be held by men and if a bull should charge one of these men a most uncomfortable fall to the rocks below would result.

Temporary marks of driftwood and paint have been placed on the difficult rookeries the past few years. Time and labor, however, have not permitted this to be done in any but a cursory fashion.

A large amount of work needs to be done in order to make the bull counts of the future satisfactory. Concrete markers should be placed at regular intervals of at least 100 feet (better every 50 feet) on the following rookeries: Gorbatch, Reef, Kitovi, Lukanin, Polovina, Morjovi, Vostochni, Zapadni, Little Zapadni, and Tolstoi. A marker 3 feet long, 1 foot square at the base, and 6 inches square at the top is suggested. It could be buried a foot in most places. It would be very desirable also to have a piece of 1-inch galvanized pipe 6 feet long set into each to facilitate handling the block and to make it much easier to see at the long distance from which counts must ordinarily be made.

Overhead runways for the observer to walk out to the crest of the beach line should be provided on most of the rookeries mentioned above. They need not be elaborate. All that is needed is a trestlework 6 feet high and a walkway 1 or 2 feet wide. No hesitation need be felt because of the effect these structures would have on the seals. In 1919 two boats remained on Reef Rookery throughout the season and the seals paid not the slightest attention to them.

This construction work which has been recommended must be done at the earliest possible moment if satisfactory census figures are desired. It can not be done now, however, in time for use in 1920. The bulls arrive in May, which is earlier than men can ordinarily get to the islands. Snow then usually covers the ground and would prevent work of the character outlined. Such work, which would involve a considerable amount of labor, must be done after August 10 if it is to be done at all, during the season when the island force would be busy at other work. It is recommended, therefore, that at least five assistants be supplied the man who directs this work. One of these should be a good carpenter who could act as foreman, and the others should be laborers. All should be taken from the States. During the sealing season there is an abundance of work elsewhere on St. Paul for them to do. As stated, they would not be needed on the rookeries until after August 10.

Too strong emphasis can not be placed on the need of the work outlined above and on the absolute necessity of its being provided for wholly by outside labor.

It may be asked, why the large St. Paul rookeries can not be counted from a boat. It is not always possible to get out on the water for this purpose, but when it is I have chosen the means in preference to the ladder for Zapadni, Little Zapadni and Tolstoi. However, these rookeries are becoming so deep that it is practically impossible to get an accurate count of bulls from a boat. The areas are too broad and the seals are too campact therein.

As the number of bulls is reduced in the herd the counting of pups will become easier and the work can be undertaken somewhat earlier. If the force of men recommended is supplied in 1920 doubtless some of the larger rookeries can be counted again. But unless a thoroughly accurate and satisfactory count of harems can be made on a rookery the count of pups is not so valuable as it otherwise would be.

PUPS.

Distribution of Pups in 1919.

Rookery.	Date of counts.	Living pups.	Dead pups.	Total pups.	Per cent dead.
ST. PAUL ISLAND.					
Kitovi		3,512	53	[a] 3,565	1.49
Lukanin		2,712	76	[a] 2,788	2.73
Gorbatch		11,878	430	[a] 12,308	3.49
Ardiguen		1,130	20	[a] 1,150	1.74
Reef		21,871	586	[a] 22,457	2.61
Sivutch		6,840	175	[a] 7,015	2.49
Lagoon	Aug. 11	430	15	445	3.37
Tolstoi		15,668	359	[a] 16,027	2.24
Zapadni		13,921	379	[a] 14,300	2.65
Little Zapadni		9,817	328	[a] 10,145	3.23
Zapadni Reef	Aug. 12	581	23	604	3.81
Polovina	Aug. 13	5,486	308	5,794	5.31
Polovina Cliffs	Aug. 14	2,148	61	2,209	2.76
Little Polovina		1,189	14	[a] 1,203	1.16
Morjovi	Aug. 14	2,953	88	3,041	2.89
Vostochni		29,480	1,383	[a] 30,863	4.48
Total		129,616	4,298	133,914	3.21
ST. GEORGE ISLAND.					
North		8,584	218	[a] 8,802	2.48
Staraya Artil	Aug. 2	5,582	164	5,746	2.85
Zapadni	Aug 5	846	11	857	1.28
South	Aug. 5	68		68	
East Reef	Aug. 4	2,345	22	2,367	.93
East Cliffs		5,297	121	[a] 5,418	2.25
Total		22,722	536	23,258	2.30
Total, both islands		152,338	4,834	157,172	3.07

[a] Based on estimated average harem.

The number of dead pups was ascertained on each rookery counted at the time the count was made. On those rookeries on which the cows and pups were estimated the number of dead was computed from the percentage of dead used in the 1918 report. The small increase in the average harem, especially on St. George, should have reduced the percentage of dead pups to a slight extent. On St. Paul, conditions were so little changed in this respect, however, that the difference would not overbalance variations due to the laws of chance. Therefore until average harems become as large as they have been in some former year (as 1916 for instance) when the death rate was determined for all of the rookeries it seems best to make no change in the percentages. The rookeries which were counted in 1919 gave no data upon which to base a reduction. In fact there was in some cases evidence of a slight increase in the number of dead pups.

INCREASE OR DECREASE IN NUMBER OF PUPS IN 1919 FROM 1918.

Rookery.	Total pups, 1918.	Total pups, 1919.	Numerical increase.	Increase (+) or decrease (−).
ST. PAUL ISLAND.				*Per cent.*
Kitovi	2,540	3,565	1,025	+40.35
Lukanin	2,235	2,788	553	+24.74
Gorbatch	9,486	12,308	2,822	+29.74
Ardiguen	792	1,150	358	+45.20
Reef	19,398	22,457	3,059	+15.76
Sivutch	6,325	7,015	690	+10.90
Lagoon	512	445	−67	−13.08
Tolstoi	16,725	16,027	−698	−4.17
Zapadni	11,460	14,300	2,840	+24.78
Little Zapadni	9,089	10,145	1,056	+11.61
Zapadni Reef	536	604	68	+12.68
Polovina	5,343	5,794	451	+8.44
Polovina Cliffs	1,882	2,209	327	+17.37
Little Polovina	1,491	1,203	−288	−19.31
Morjovi	3,335	3,041	−294	−8.81
Vostochni	31,468	30,863	−605	−1.92
Total	122,617	133,914	11,297	+9.21
ST. GEORGE ISLAND.				
North	7,011	8,802	1,791	+25.54
Staraya Artil	5,440	5,746	306	+5.62
Zapadni	806	857	51	+6.32
South	61	68	7	+11.47
East Reef	2,120	2,367	247	+11.65
East Cliffs	4,860	5,418	558	+11.48
Total	20,298	23,258	2,960	+14.58
Total, both islands	142,915	157,172	14,257	+9.97

A casual inspection of the foregoing table discloses a great variation in the growth of the various rookeries. It ranges from a loss of 19.31 per cent in one case to a gain of 45.20 per cent in another. Some of this variation might be attributed to the defects in the method of arriving at the number of pups on rookeries not actually counted, but it can not explain it all. A constant rate of increase simply is not a phase of rookery development, and this is the greatest objection to the use of a single breeding area as a type in census calculations.

COWS.

NUMBER.

The number of breeding cows is by inference the same as the number of pups, since but a single young is born annually. Although a birth of twins is unknown in the species, it is not believed to be entirely impossible from an anatomical standpoint and may on very rare occasions occur.

The figures for the pups show that there has been an increase of cows of 9.97 per cent from 1918. This figure is to be compared with 11.63 per cent for 1918.

The figures show that the average annual increase is between 9 and 10 per cent under present conditions. This is an exceedingly slow rate of growth for animals which live as long and breed as often as fur seals. It emphasizes the enormous loss the species suffers annually from some enemy of which we know practically nothing. It now seems certain that 50 per cent of all animals born are lost

before they attain the third year. Since an exceedingly small proportion is weak physically, it seems evident that the great loss is due to a predatory animal.

LOSS.

The loss of cows on the islands due to rookery conditions continues to be large, but a decrease from 1918 is noted. This result would naturally be expected from the increase in the average harem, although small, and the consequent less crowded condition. The dead cows found on five St. Paul rookeries numbered 15. The total alive on the same areas was 12,093. This proportion (0.001240) applied to the entire herd indicates a total loss of 195 cows. This number is to be compared with 213 for 1918, 129 for 1917, and 39 for 1916. With an increase in the average harem to about 40 there should be a material reduction in this loss.

The practice of killing seals up to August 10 grew up when the herd was smaller and much time could be taken in the segregation of the animals. The natives were thus provided with fresh food 10 days longer. At the present time the practice can hardly be excused on these grounds. The males which would ordinarily be taken in this period can be secured before, at least in large part, by a slight speeding up of the work.

AGES.

The maximum age of cows is yet unknown. Animals of the 1902 series (branded 1896 to 1902 inclusive) were observed in 1919 to the number of nine. This is a larger number than has been previously recorded for several years. Close watch was kept for them. This is considered a large number in view of the fact that the youngest are at least 17 years old and have passed through at least 10 years of pelagic sealing. The number branded of which records are available was 19,587. St. George brandings from 1898 to 1902, inclusive, are not available.

C. E. Crompton reported seeing a cow on Staraya Artil Rookery August 2, 1919, with the one bar across the back characteristic of the 1902 series and, in addition, a longitudinal bar on the left side. No record of such a brand was made on St. Paul Island, so it is probably a St. George seal.

Cows of the 1912 series were especially in evidence, possibly because branded animals were being searched for. Four were seen in one day on St. George. They have been seen on rookeries occasionally where it is known they were not born. This lends weight to the theory that the cows wander considerably from place to place, whereas it is known that adult males do not do so to nearly the extent that was formerly supposed. In less than half a dozen cases have males of this series been seen away from parent rookeries since they became 6 years old.

BULLS.

HAREM AND IDLE BULLS.

The count of bulls, harem and idle, made at the height of the breeding season furnishes the most reliable data obtainable at present upon which to base the census. From this the average harem can be

computed on the several rookeries with a reasonable degree of accuracy, providing the number of cows is ascertained for some of them; and it is possible to determine fairly well about what the average harem will be from the proportion of idle bulls found at the height of the season.

The enumeration of the bulls is conducted with increased difficulty each year. It seems likely that unless some means are devised whereby the animals on the large rookeries can be brought within view the work must be given up in a few years, except on the smaller areas and sections. If the plans which are under consideration, however, are carried out it is believed that in a few years it will be possible to make this count accurately regardless of the growth of the herd. In no other way is it believed possible to keep a sufficiently accurate check on the herd to determine quotas for killing in advance with the provision of just enough reserve for breeding purposes.

Owing to adverse weather conditions it was not possible to make a count of bulls on Sea Lion Rock (Sivutch Rookery). The number was taken as the same as found in 1918 since this area being circumscribed by natural limits forbids any great amount of annual change.

The following table shows the results of the count:

Harem and Idle Bulls and Percentage of Idle Bulls to Harem Bulls Compared to Average Harem, 1919.

Rookery.	Date.	Harem bulls.	Idle bulls.	Total.	Idle bulls to harem bulls.	Average harem.
ST. PAUL ISLAND.					*Per cent.*	*Per cent.*
Kitovi	July 16	155	75	230	48.38	23.00
Lukanin	...do....	110	80	190	72.72	25.34
Gorbatch	...do....	362	95	457	26.24	34.00
Ardiguen	...do....	46	18	64	39.13	25.00
Reef	...do....	720	162	882	22.50	31.19
Sivutch	(a)	230	90	320	39.13	30.50
Lagoon	July 17	17	6	23	35.29	26.18
Tolstoi	...do....	538	154	692	28.62	29.79
Zapadni	...do....	546	246	792	45.05	26.19
Little Zapadni	...do....	344	145	489	42.15	29.49
Zapadni Reef	...do....	28	6	34	21.42	21.57
Polovina	July 15	192	102	294	53.12	30.18
Polovina Cliffs	...do....	96	48	144	50.00	23.01
Little Polovina	...do....	38	23	61	60.52	31.66
Morjovi	July 14	147	87	234	59.18	20.69
Vostochni	...do....	1,004	821	1,825	81.77	30.74
Total		4,573	2,158	6,731	47.19	29.28
ST. GEORGE ISLAND.						
North	July 21	225	21	246	9.33	39.12
Staraya Artil	...do....	124	14	138	11.29	46.34
Zapadni	...do....	27	6	33	22.22	31.74
South	...do....	5	3	8	60.00	13.60
East Reef	July 19	75	23	98	30.66	31.56
East Cliffs	...do....	129	14	143	10.85	42.00
Total		585	81	666	13.84	39.76
Total, both islands		5,158	2,239	7,397	43.40	30.47

[a] Count of 1918.

The most significant fact to be noted in the foregoing table is the falling off of the number of bulls. This was greatly desired by all who had the welfare of the herd in mind. Later counts showed that it was accompanied with an increase in the size of the harem, not a great deal

to be sure, but more than had been expected. It was not thought that the enormous excess of males which had been in reserve owing to the closed season of 1912–1917 could be noticeably reduced in a single season of commercial work; yet it was done and speaks well for the conduct of the business by the island authorities. It should be noted that not only the total number of bulls was slightly reduced but that the percentage of idle bulls to harem bulls grew less. This is the best evidence that the reasoning was sound which led to the conclusion in former years that a proportion of one idle bull to two harem bulls produced the minimum average harem; and that this latter is very close to 26, regardless of amount of male life, is a foregone conclusion.

AVERAGE HAREM.

The counting of pups on certain of the rookeries enabled the determination of the average harem on the rookeries counted. The information derived therefrom, coupled with observation on the ground, led to the results given in the table below. For purposes of comparison the average harems in 1918 are given, showing graphically the increase in size of harems.

AVERAGE HAREM IN 1919 FOR ALL ROOKERIES.

Rookery.	Breeding cows.	Harem bulls.	Average harem, 1919.	Average harem, 1918.
ST. PAUL ISLAND.				
Kitovi	3,565	155	[a] 23.00	[a] 20.00
Lukanin	2,788	110	[a] 25.34	[a] 22.35
Gorbatch	12,308	362	[a] 34.00	[a] 31.00
Ardiguen	1,150	46	[a] 25.00	[a] 22.00
Reef	22,457	720	[a] 31.19	[b] 28.19
Sivutch	7,015	230	[a] 30.50	[a] 27.50
Lagoon	445	17	[b] 26.18	[b] 20.48
Tolstoi	16,027	538	[a] 29.79	[a] 26.76
Zapadni	14,300	546	[a] 26.19	[a] 23.19
Little Zapadni	10,145	344	[a] 29.49	[a] 26.49
Zapadni Reef	604	28	[b] 21.57	[b] 19.85
Polovina	5,794	192	[b] 30.18	[b] 28.88
Polovina Cliffs	2,209	96	[b] 23.01	[a] 20.23
Little Polovina	1,203	38	[a] 31.66	[a] 28.67
Morjovi	3,041	147	[b] 20.69	[a] 23.00
Vostochni	30,863	1,004	[a] 30.74	[a] 27.74
Total	133,914	4,573	29.28	26.59
Total for rookeries counted	12,093	480	25.19	27.88
ST. GEORGE ISLAND.				
North	8,802	225	[a] 39.12	[a] 26.75
Staraya Artil	5,746	124	[b] 46.34	[a] 34.00
Zapadni	857	27	[b] 31.74	[b] 18.74
South	68	5	[b] 13.60	[b] 7.62
East Reef	2,367	75	[b] 31.56	[b] 21.41
East Cliffs	5,418	129	[a] 42.00	[a] 30.00
Total	23,258	585	39.76	27.65
Total for rookeries counted	9,038	231	39.42	19.91
Total, both islands	157,172	5,158	30.47	26.74

[a] Estimate. [b] Pups counted.

The most significant information bearing upon the average harem is furnished by Polovina Rookery. In 1918 it had 185 harems and

5,343 cows, an average of 28.88. The number of harems on the entire island of St. Paul was less in 1919 than in 1918, but Polovina increased by 7. This, together with field observations, indicates that there was an excessive influx of bulls on this rookery, which operated to prevent the average harem in 1919 becoming as much larger than the general average as it otherwise would. In the light of the knowledge acquired on the migration of adult seals in 1919 it seems very plausible that the limited driving and killing from this place would tend to preserve here a larger excess than on rookeries where commercial operations are more extensive. In other words, the absence of driving and killing of males on a rookery hauling ground seems in general to tend to preserve a surplus which in later years floods the rookery. The same factor would be in operation at Northeast Point, which was not driven during the closed season and not fully driven in 1918.

SIZES OF BULLS.

The actual size of some adult bulls which appear in the early drives of the season has been variously estimated. There is great variation in animals full grown both in weight and length. The heaviest bull weighed 604 pounds after being bled; many of them exceed 550. One animal measured 87 inches from the tip of the nose to the base of the tail, and practically all that approached maturity exceeded 72 inches. These results lead to the conclusion that the maximum size of early-arrived full-grown rookery bulls is about 7½ feet in length and 700 pounds in weight. The average is about 6½ feet in length and 550 pounds in weight. It therefore seems clear that the 7-year-old animals of the 1912 branded series were not in 1919 nearly grown. It now seems to be true that an animal able to hold a harem on a crowded rookery must be at least 10 years old. No 7-year-old was noted in 1919 which would even come into the category of idle bulls.

SURPLUS BULLS.

The surplus-bull class is fast disappearing, and 1919 is probably the last year it will be of sufficient importance to be considered. In addition to the old-age loss of 20 per cent which has been allowed, it seems altogether probable that 50 per cent has been lost through natural causes. Of course this has not all taken place in the one year, but is the cumulative loss, of an individual age class, for instance, from the fourth to the seventh year. Heretofore there has been absolutely no basis for the computation of such a loss; it was considered to be small and did not enter into the computations. After 1920 it is believed information will be available which will enable the loss to be stated fairly accurately for the third to the fourth years and less so subsequently; possibly it will necessitate a revision of the losses arbitrarily adopted below the third year. It will probably not materially change the loss of 50 per cent the first three years, however, as each year's work seems to indicate that this is very close to the actual condition.

The assumption of five breeding years for the males does not seem as yet to need revision. Certainly when bulls are abundant and there is great strife on the breeding grounds an animal must be well developed and at least 8 to 10 years of age before he can hold a position,

and five years of fighting will probably wear him out. When they are less numerous and there is but little fighting to be done the breeding period is certainly much longer. A 7-year-old bull is sufficiently developed sexually to have a harem, and it is not doubted they will do so when the average harem shall have increased to about 40. When this occurs it will necessitate the assumption of less than 20 per cent annual old-age loss of bulls.

ENEMIES.

The only enemy of which we can be sure is the killer whale. The voracious attacks of this animal on the fur-seal pups have been too well described to need repeating here, but they would not have to continue long to account for the entire loss.

The urgent need of combating this animal is easily seen. Out of 150,000 animals born in 1919, 75,000 are sure to perish before they are of any value to the herd or to man. At the present value of furs these would be worth over $5,000,000. Of course all of the enemies could not be eliminated in any one year, but it is quite evident that it would be financially profitable to make a determined start.

It also is desirable in this connection to point to the paucity of information about the fur seals at sea. The animal is so exceedingly valuable that it is very desirable to have its habits and habitats thoroughly investigated. There may be other enemies just as bad as the killer, but any such conjecture emphasizes our ignorance.

INTERISLAND MIGRATION OF MALES.

In 1914 and 1915 it was determined beyond question or doubt that 2 and 3 year old males haul out indiscriminately on any hauling ground on either island. This was learned by clipping the hair from the heads of branded seals. On St. Paul the right side was clipped and on St. George the left; this made it possible at a later date to identify the animals which had been handled. The same thing had been determined, perhaps less satisfactorily, a great many years before by clipping the ears of pups.

It was supposed from this that there was indiscriminate mixing among the older classes, and little attention was given the subject until 1919.

In the commercial operations of 1918–19 it has been noted that only in two or three instances have branded males of the 1912 series been seen on rookeries other than those upon which they were marked in 1912; but they have appeared in respectable numbers on those.

The absence of large males on the St. George hauling grounds in 1919 in the numbers which were expected led to a close inquiry into the subject. Constant effort was made to secure a quota which had been tentatively set, but the 6-year-olds and over were not available. Upon my arrival from St. Paul in census study this was particularly noticeable and was borne out in the bull counts and average-harem computations.

COMPLETE CENSUS OF FUR SEALS AS OF AUGUST 10, 1919.

Pups, counted and estimated		157, 172
Breeding cows, 3 years old and over, by inference		157, 172
Harem bulls, counted		5, 158
Idle bulls, counted		2, 239
Yearlings, male and female, estimated:		
Pups born in 1918	142, 915	
35 per cent deducted for natural mortality	50, 020	
Yearlings, both sexes, beginning 1919	92, 895	
Yearling females, 50 per cent, Aug. 10, 1919	46, 447	46, 447
Yearling males, beginning of 1919	46, 448	
Yearling males killed in 1919	4	
Yearling males, Aug. 10, 1919		46, 444
2-year-olds, male and female, estimated:		
Yearling females, Aug. 10, 1918	41, 608	
20 per cent deducted for natural mortality	8, 321	
2-year-old females, Aug. 10, 1919		33, 287
Yearling males, August 10, 1918	41, 595	
Yearling males killed, fall of 1918	2	
Yearling males, end of 1918	41, 593	
20 per cent deducted for natural mortality	8, 318	
2-year-old males, beginning of 1919	33, 275	
2-year-old males killed in 1919	194	
2-year-old males, Aug. 10, 1919		33, 081
3-year-old males, estimated:		
2-year-old males, Aug. 10, 1918	30, 159	
2-year-old males killed, fall of 1918	14	
2-year-old males, end of 1918	30, 145	
5 per cent deducted for natural mortality	1, 507	
3-year-old males, beginning of 1919	28, 638	
3-year-old males killed in 1919	15, 042	
3-year-old males, Aug. 10, 1919		13, 596
4-year-old males, estimated:		
3-year-old males, Aug. 10, 1918	9, 117	
3-year-old males killed fall of 1918	552	
3-year-old males, end of 1918	8, 565	
5 per cent deducted for natural mortality	428	
4-year-old males, beginning of 1919	8, 137	
4-year-old males killed in 1919	2, 390	
4-year-old males, Aug. 10, 1919		5, 747
5-year-old males, estimated:		
4-year-old males, Aug. 10, 1918	7, 114	
4-year-old males killed fall of 1918	229	
4-year-old males, end of 1918	6, 885	
5 per cent deducted for natural mortality	344	
5-year-old males, beginning of 1919	6, 541	
5-year-old males killed in 1919	1, 259	
5-year-old males, Aug. 10, 1919		5, 282

6-year-old males, estimated:		
5-year-old males, Aug. 10, 1918	11,941	
5-year-old males killed, fall of 1918	148	
5-year-old males, end of 1918	11,793	
5 per cent deducted for natural mortality	589	
6-year-old males, beginning of 1919	11,204	
6-year-old males killed in 1919	2,213	
6-year-old males, Aug. 10, 1919		8,991
Surplus bulls, counted and estimated:		
Breeding bulls in 1918	7,788	
20 per cent deducted for old-age loss	1,557	
1918 bulls remaining in 1919	6,231	
Breeding bulls in 1919	7,397	
1918 bulls remaining, deducted	6,231	
Increment of new bulls in 1919	1,166	
6-year-old males in 1918	13,755	
Surplus bulls in 1918	17,110	
Total surplus bull stock for 1919	30,865	
Deduct number killed, fall of 1918	64	
Surplus bulls at end of 1918	30,801	
20 per cent deducted for old-age loss	6,160	
Remaining surplus for 1919	24,641	
7-year-olds and over killed in 1919	4,238	
Total surplus in 1919	20,403	
Increment of new breeding bulls in 1919 deducted	1,166	
Surplus bulls in 1919	19,237	
Estimated 50 per cent loss due to fighting and natural causes	9,618	
Surplus bulls, Aug. 10, 1919		9,619

RECAPITULATION.

Pups	157,172
Cows	157,172
Harem bulls	5,158
Idle bulls	2,239
Yearling females	46,447
Yearling males	46,444
2-year-old females	33,287
2-year-old males	33,081
3-year-old males	13,596
4-year-old males	5,747
5-year-old males	5,282
6-year-old males	8,991
Surplus bulls	9,619
Total	524,235

SPECIAL INVESTIGATION OF COPPER RIVER SALMON FISHERY.

By Henry B. Ward.

GENERAL DESCRIPTION OF REGION.

The Copper River, which empties into the Gulf of Alaska at approximately the highest point of the crescent of shore that forms the northern boundary of the gulf, has long been known as one of the important salmon streams of Alaska. The records of its yield are found in the publications and other documents of the Bureau of Fisheries and need not be recounted here. The value of the fisheries on the flats at its mouth and in its course has led to active competition for the fishing rights of the district and to the multiplication of canneries, as well as boats and gear engaged in catching the salmon that visit it annually.

The effect of the steady and increasing draft upon its fish supply resulted in protests that culminated in hearings held by the Bureau of Fisheries in 1917 and in 1918 with a view to determining the necessity of limiting or prohibiting commercial fishing for salmon in the river itself, with its tributary streams, and in its delta waters.

The evidence presented at these hearings was in part contradictory and indicated an unfortunate lack of precise knowledge with reference to the conditions that prevailed. There was especial lack of information with reference to the location and extent of the spawning grounds to which the salmon resorted on their ascent of the river, and it was decided to extend the knowledge of the situation by making a study of the stream and its main tributaries, with a view to determining precisely where the fish went and what conditions they found for spawning. It was with this purpose in view that the party spent six weeks in the Copper River Valley and its vicinity, gathering information by inquiry from those well acquainted with the region, but especially by a study at first hand of the river and its tributaries, so far as the time sufficed for this purpose. A brief statement regarding the territory itself will serve to give proper orientation for the account of the work which follows.

The Copper River has its source in a large glacier on the northern slope of Mount Wrangell, and after flowing a short distance northward through a narrow valley comes out into the broad gravel-floored area known as the Copper River Basin, which stretches from the northern slope of the Chugach Mountains to the foothills of the Alaska Range. In this plain the river turns gradually in a huge circle around Mount Wrangell as a center, and about 50 miles from it, until it reaches a point almost directly south of the mountain and 40 miles from it. Here it is met by the Chitina River, flowing in from the eastward. In the course of its circle around Mount Wrangell the Copper River receives a number of important tributaries—the Chistochina, the Gakona, and the Gulkana Rivers from the north, and the Tonsina, Tazlina, and Klutina Rivers from the west.

From the point of its union with the Chitina, the Copper River flows almost directly south through a narrow valley, at one point constricted into a real box canyon, but nowhere possessed of a wide

basin, and confined so closely by the Chugach Mountains that the streams tributary to it are short and turbulent, often blocked by impassable falls within a short distance of the point where they join the main river. Furthermore, in the 70-mile stretch from the mouth of the Chitina to the delta, the Tiekel and the Tasnuna from the west and the Bremner from the east are the only streams of any particular size. These factors have an important bearing upon the question of the spawning places of the salmon.

Copper River Valley.

The Copper River itself is heavily silt laden, and its waters nowhere and at no time during the period of migration are clear enough to afford a view of the fish, except where the salmon break the surface in their movements. During its course through the plateau it is more or less spread out in numerous channels intercepted by sand bars and islands, and even through the mountains the same characteristics manifest themselves wherever the steep, rocky slopes on the east and west are sufficiently separated from each other to afford any opportunity for the deposit of a sand-and-silt plain. While short

stretches are apparently quiet, the stream even here runs with considerable swiftness, and for the major part of its course is so rapid as to be cutting and shifting its channel constantly, while at a few points its turbulent waters dash over the rocks in its bed with such violence that the current offers a most formidable obstacle even to the progress of powerful fish like the salmon.

Just above the delta, about 30 miles distant from the flats, the stream makes an abrupt angle to the west and again to the south in passing the Childs and Miles Glaciers, which approach it directly from the east and west, and which seem to have formerly confined it very narrowly, since they were separated by only a mile at the narrowest point. At present an enlargement of the stream, known as Miles Lake, intervenes between the two glaciers. It is 4 miles long, and more than half that wide. Below it the river traverses a broader plain, within which its channels are constantly shifting, and expands into a network that stretches into the delta, involving an area of flats and sloughs that in the extreme is not less than 12 or 15 miles wide. These channels communicate directly with those of the Martin River, a smaller glacial stream to the eastward, and less intimately on the other side with streams from the Sherman Glacier, although farther westward various channels interlace over a common mud plain until they connect, in fact, with the channel of the Eyak River at the extreme west of this flat low-lying shore of mud and sand.

Supt. J. R. Russell, of Birdsview, Wash., was detailed to assist in this work. Prof. W. A. Oldfather, of the University of Illinois, went along as assistant. The party was augmented at Copper Center by the addition of Frank H. Carroll, who had been secured as guide and packer for the part of the work covering the trip through the wilderness.

A collapsible boat was taken for use on the lakes. It proved exceedingly difficult to transport, and yet without it it would have been impossible to secure the essential information on the lakes and at the spawning grounds.

CHRONOLOGICAL OUTLINE OF TRIP.

The party reached Cordova the morning of July 17, 1919, on which date the author had an extended conference with E. M. Ball, from whom he learned at first hand important facts concerning the general situation. The following day was devoted to an inspection of Eyak Lake in which some red salmon were spawning at that time. On July 19 a visit was paid to Eyak cannery on the flats near the mouth of the river and the fish taken by their fishermen were carefully studied. On July 20 the writer met Arthur H. Miller, who is in charge of the work of the Bureau of Education among certain natives of Alaska, and discussed with him the evidence concerning the run of red salmon on the Copper River in so far as it was furnished by the experiences of the native fishermen. During that and previous days incidental visits were made to the plants of the salmon-packing companies located at and near Cordova. Thereby opportunity was offered to inspect fish coming from the flats of the Copper River and to compare them with fish brought in from other localities in the district.

Since the railroad schedule of two trains per week was entirely inadequate for any work on the upper river, arrangements were made for a speeder to carry the party over the road as desired. The first trip was made on July 21, to the head of the Abercrombie Rapids, many stops being made to take views of the stream and to study the currents and probable course of the fish in ascending the river. Especial attention was paid to the Abercrombie Rapids themselves, and both banks of the stream were examined carefully. Along the railroad track were various dipping stations at the margin of the water where men were at work; these places were inspected closely and studied from various aspects of the problem. The other side, formerly fished by the Carlisle Packing Co., but now closed territory, was not visited, as it could be reasonably well studied from the top of the west bank. The problem of fishing in these rapids is discussed at another point.

On July 22 a visit was made to Clear Creek, a tributary on the east side of the Copper River, where the railroad crossed it at Mile 43. Redfish were spawning there, and a careful study of this stream was made, the peculiar conditions of which are discussed in another section of this report.

July 23 was spent at the plant of the Abercrombie Packing Co. in an examination of the fish and a comparison of them with the material studied at an earlier date as noted above. On the following days this comparative study was carried further by the examination of new material in the canning plants at Cordova. At the same time equipment and apparatus were prepared for the trail and packed.

The party left Cordova for the trip to the interior early on the morning of July 26. On the way north stops were made to investigate small streams emptying into the Copper River from the west, also certain small lakes that lie between the Tasnuna River and the north wall of its valley. They are located in the alluvial plain near the junction of the river with the Copper, and despite reports show no evidence of being waters in which the salmon were about to spawn or of having served such a purpose previously. The small tributaries on the west which were said to carry salmon showed no trace of fish at that time and no evidence of spawning during that season. It seems probable that they are not used by the red salmon, though some are not unlikely to furnish spawning places for the silver salmon which run up later.

An entire day was devoted to the study of Long Lake which has been reported as an important spawning ground for salmon. The results of the investigation are discussed in a separate section of this report.

On July 29 the party left the railroad at Chitina and investigated the lakes there and the small stream that joins them with the Copper, which are certainly good spawning grounds for the red salmon as shown by the record of observations, given later in this report. The party left that day for Copper Center, reaching the road house at the latter point late in the evening. The following day was devoted to an investigation of adjacent portions of the Copper River and of the Klutina, which joins it at Copper Center. An opportunity was given to observe the methods of fishing practiced by the natives there and to confirm by general testimony the statements concern-

ing catches of salmon made this year and last year as had been reported previously. The salmon wheels used by the natives are crude contrivances but are well located and undoubtedly give reliable evidence concerning the movements of the salmon and the number of fish which go upstream. They are kept under continuous observation and are visited fairly regularly by the women, so that even if the men are away on hunting trips or working on the road, the records of the wheel represent its continuous service. There can be little doubt that in 1918 the run of salmon was so small as to furnish only very scanty supplies of fish to the natives, even though the number of wheels at work was several times greater than before. During the season of the investigation the run had been much larger and some families had already caught and dried an adequate supply of fish to carry them over the winter. Some wheels continued to work even until the party returned to this point in September, and furnished a regular supply of food for the natives. All persons interviewed agreed that the run of fish had been good and that it was very much larger than the year before. By cable message received that evening, Mr. Russell was called back to Cordova for conference with Field Assistant O'Malley and did not participate in the later work of the party until August 11.

On July 31 the pack train was loaded and the party started on the trail up the north bank of the Klutina. Because of an accident that threatened to be serious, it was necessary to send the guide back to Copper Center on the following day, and the party did not reach the camp at the foot of Lake Klutina until late in the afternoon of August 5. The camp was located on the river half a mile below the outlet of the lake and directly across the stream from a large eddy in which salmon were seen jumping and above which an old camp and drying rack gave evidence of previous salmon-catching operations by both natives and white men. The following day was devoted to a study of the southeast shore of the lake and the tributaries emptying into it and to fishing in the eddy opposite camp. On August 7 the red salmon caught in the eddy were studied and further examination was made of the tributary streams near the outlet of the lake. The largest stream, known as Salmon Creek, which is the only one of any considerable size, evidently constitutes an important spawning ground for red salmon and is discussed in detail later.

The northeast shore of the lake was carefully studied on August 9 when camp was moved to a point near the mouth of St. Anne Creek. The streams which empty into the lake along that stretch are very small. At that season the outlets were choked with logs and débris. The amount of water flowing from them was limited, and the area available for spawning purposes under any circumstances must be insignificant. No traces were found in the lake or in the streams mentioned near the lake of present or previous spawning activities on the part of red salmon. August 10 was devoted to a study of the lower section of St. Anne Creek, where red salmon both spawning and spawned out were numerous. One king salmon was also seen floating downstream. The details of that examination are given at another point. On August 11 camp was moved to the head of the lake and the west shore studied carefully en route. No evidence of the presence of salmon or of spawning activities was seen until the party,

augmented by the return of Mr. Russell, reached the extreme southwest angle of the lake. There the salmon were jumping in numbers in water near the shore where camp was located.

The extreme tip of the lake is bluntly truncated and receives the waters of both the Hallet River and the upper Klutina. The latter empties into it through numerous channels and the former by a single stream, which, though it originates to the westward and traverses a valley separated from the Klutina by a considerable mass of mountains, enters close to the west channel of the Klutina and parallels it for a stretch such that it seems to be at first sight a part of the Klutina complex. The valley of the upper Klutina is broad and flat and traversed by a series of connecting channels; it is occupied also by a considerable number of small lakes. Both the sloughs on the flat and the channels are significant factors in the spawning of the red salmon. The conditions are discussed in the section devoted to the upper Klutina.

The party spent nearly a week in the investigation of that region and left on August 19, stopping at the old camp on the lake shore near the mouth of St. Anne Creek. Opportunity was then given to examine that stream for the second time and to note the contrast with conditions observed a week earlier. On August 20 camp was moved again and the party proceeded to St. Anne Lake, where a two-day stop was made. That lake is evidently very important for the fishery problems of that region and is described in detail in another section. It took two days to cross from St. Anne Lake to Lake Tazlina, where the party camped near the outlet late in the afternoon of August 23.

A study of the southeast shore of the lake showed only scanty evidence of the presence of red salmon. Near the place where the shore turns sharply toward the south is a fair-sized creek, but neither this nor the larger stream which was nearer camp yielded any evidence of the visitation of red salmon during that season. Only a single dead redfish was seen floating in the lake in the trip of 10 miles from camp to the angle, and only two were found lying on the beach in the same distance. Although the guide stated that two Norwegians, who camped near the angle of the lake some years ago, caught plenty of redfish in a net set in an eddy near their camp, there was no evidence of the presence of any number of fish at the time of the visit. It would have been worth while to stop at that point to test the condition of the waters in which they had fished at an earlier date, but circumstances prevented. A few more fish were encountered along the beach near the south end of the lake, but none were seen living or floating in that section, and the few small streams which empty into the lake along that shore yielded absolutely no evidence of present or past spawning activity of the red salmon. During the period of the visit to the head of the lake the shore was pounded by a surf such as to indicate its unfitness for salmon spawning. If by chance any fish had reached that region and spawned, their activities were misdirected, for the eggs would have had no chance to develop. However, there is no reason to suppose that they ever attempt to spawn along that section of the lake, and, in fact, all of the fish that were seen along the entire southeasterly shore of the lake might easily have been dead fish floating at the surface, carried into that territory

by storms and winds, even though the shore is 5 miles distant from the opposite shore where later salmon were found in certain streams.

At the head of the lake the foot of the glacier is separated from the lake water by a strip of sand and gravel practically entirely without vegetation and at most not 2 miles wide. The channels that carried the glacial water to the lake are evidently shifting and unstable and hence entirely unfitted for the spawning of the salmon. Conditions in such respect were sharply contrasted with those found at the head of Lake Klutina. While each of the channels was studied camp was located on the west side of the lake at a point similar to that utilized for a camp at the head of Lake Klutina. Although the net was put out at that point and maintained at several near-by positions during the entire stay, not a single fish of any kind was caught nor a dead salmon found on the shore anywhere.

On August 26 camp was moved to a point near the mouth of the Nelchina River, and the shore intervening between the two places was studied. No evidence of any kind was obtained to indicate the present or previous presence of salmon at any point along the strip from the head of the lake to the mouth of the Nelchina River. The Nelchina is split up into a considerable number of channels, and it would have required more time than was available to have made a careful study of them. It is reported that red salmon ascend that river for spawning, but there was no evidence of their presence in the stream in the very brief observation made in passing.

On August 29 the lower Mendeltna River was explored, and living red salmon not yet spawned out were found. The number was not large, and there were no dead fish on the shore in the lower regions of the stream nor any fish skeletons or bear trails along the shore to indicate that fish had been more abundant there earlier in the year. It is said that the red salmon ascend to lakes some 12 to 15 miles upstream in which they spawn. In the absence of trails it would have been impossible to make the trip upstream without a larger expenditure of time than was available, so that the questions of the number of fish which utilized the stream for spawning purposes, the suitability of the river for such a use, and the numbers actually present all had to be left for future determination. That night camp was located close to the outlet of Lake Tazlina at a cabin known as the home of a former prominent Copper River Indian called Tazlina Johnny. The place was not inhabited, because of his death last winter. It was evident that regular and successful fishing operations had been carried out at that point in previous times. A net was set from stakes which had been located evidently for salmon fishing in a very small indentation of the shore near the cabin, and within a short time a considerable number of fish were secured. The largest male was not fully ripe, and all of the fish were in good condition, though not so large and well nourished on the average as those caught in Lake Klutina. They were carefully examined and data recorded for comparing them with the fish obtained at other localities. It is worthy of special notice that fish were still running upstream there and were not yet fully ripe, although it was the end of August.

On August 31 the return trip was begun down the valley of the Tazlina River. Inasmuch as the trail for the greater part of the way was some distance from the river, there was no opportunity to study

the stream or to get evidence concerning the possible presence of salmon in it at that time. The country was too difficult and the time too short to justify any attempt to follow the stream or to work in it between the lake and its junction with the Copper. When Copper Center was reached on September 4 the natives were still catching some red salmon in the Copper above the mouth of the Klutina, but according to their views the run had practically ceased. Only one salmon wheel was seen still fishing in the stream.

The return trip was made without further attempt to study the salmon problem in the field, but in crossing Clear Creek (Sept. 6) salmon were seen still spawning in the waters near the bridge where they had been studied nearly seven weeks earlier. However, the records of the fishermen and statements of the inspectors located at Abercrombie Rapids indicated clearly that in the main stream the run of red salmon had ceased and practically only silver salmon were being caught.

Along the south shore of Eyak Lake near Cordova, a large school of red salmon was seen on the spawning beds in one of the shallow bays. There was no opportunity to examine into their condition, but it did not look as if all were spent fish.

CLEAR CREEK.

Clear Creek is a small tributary which, coming from the northeast, flows into the Copper River near its mouth. It rises in the mountains lying immediately east of the river, and its headwaters seem to be in Goat Mountain. Where the railroad crosses the stream at Mile 43 the channel is about 100 feet wide and 1 to 3 feet deep. It preserves this character from that point to its junction with the Copper River, which is distant 1½ miles by stream, but consderably less in a direct line from the railroad bridge. The creek has a moderate flow of water which, at the time of our visit, was absolutely clear and free from any traces of glacial material. The bottom consists of gravel, with occasional small patches of mud, but no rock bottom was found. The current is moderate and fairly constant, being everywhere sufficiently noticeable to preclude the possibility of construing it as equivalent to a lake and yet at no point violent. The party walked down the stream to its junction with the Copper River. A few salmon were playing around near the railroad bridge and had evidently been at work sweeping out nests and preparing the ground for spawning. The fish were not fully ripe, although some males had begun to assume a bright coloring. A few red salmon were seen at various other points in the creek, but no large number in any one group until a point was reached three-fourths of a mile from the bridge and below a stretch of ripples in the stream where two or three groups aggregating at least 200 fish were found. They showed little fungus and only very occasional evidence of physical injury. All were in good condition, and a few of them were taking on the brilliant red of the mature male. Numerous bear tracks were seen along the shore, and trails led down through the grass and alder thickets to points where these animals had evidently been watching for fish. No evidence was obtained that the bears had been successful in their efforts to catch the salmon, and the banks were entirely free from half-eaten fish and skeletons such as were seen in other places later.

After returning to the railroad bridge a trip was made upstream far enough to reach the point at which it emerged from the narrow valley in the mountains where it originated. The stream was admirably adapted to be the spawning ground for the salmon, and its waters were already well occupied by fish approaching maturity. Two hundred yards above the bridge was a group of about 100 fish of all colors, a majority of which were well marked with red. Every few yards farther another school was brought to light, varying in size in a manner apparently well related to the area available in that particular pool or curve of the stream. About a mile or less above the bridge the stream flowed through a low flat area where its gentle current suggested lake conditions. It was slow and quiet as well as warmer than the water in the stream below. This stretch was shallow and bordered by rushes and sedges, and near it were some little sloughs communicating with the main creek where there was an abundance of green algæ and some clumps of water grasses. In these places large numbers of salmon fry were found. They were chiefly sockeyes, though some young silver salmon were captured also. Near the mouth of the canyon the valley was about one-half mile wide, the stream winding with a more rapid flow as it descended from the mountains. The topography of the country clearly showed that there was no lake on the stream above that point, and there the creek showed no evidence of the presence of salmon. In fact, none were seen above the slow quiet stretch passing through the boggy area. The temperature in the quiet stretch was from 1° to 2° higher than in the water below, and the reason was soon found in the presence of seepage areas and springs in the bottom of the stream where water entered in sufficient quantities to make the volume of flow near the railroad bridge two or three times that which was present at the place where the stream passed through the swamp. Clear Creek was visited again on September 6 when on the way back to Cordova. Spawning salmon were still present in the water near the railroad bridge. There was no opportunity at that time to investigate them or the stream further.

ABERCROMBIE CANYON AND RAPIDS.

In view of the conflicting statements concerning the actions of the salmon ascending this part of the stream, the author devoted especial attention to the conditions found there. At the time of the first visit on July 21 the stream was high and, though it did not present absolute maximum conditions, it gave a clear general idea of the difficulties which the salmon have to meet during the periods of high water. Upon returning in September the water had subsided very distinctly and it was easy to compare the conditions then existing with those seen on the former visit. Furthermore, visits were made to the canyon on several occasions during the first week of study of the Copper River. In that time the varying weather conditions affected noticeably the height of the water. Taking all things into account it seems certain that the conditions were not greatly modified by changes in water level and that the salmon that ascend the stream are subject to similar if not identical difficulties whether they go up at high water or low.

It is true that the shifting of the level makes it possible to fish from certain platforms at one stage of the water and necessitates moving them as the water level varies. It is also stated by the fishermen that some places which are good fishing stations at one water level do not yield any considerable number of salmon when the water level has changed. But such statements as these deal with details of the situation and not with the real problem. The drop in the canyon is considerable. Within a distance of 1½ miles the water descends approximately 50 feet. The west bank of the river is very steep and made up almost exclusively of large broken rock fragments. As these lie they build scallops in the bank that are of varying size. Walking along the rocks near the water's edge one can see very distinctly that the current of the river is checked very radically near the shore and at some points actually takes the reverse direction from that in midstream. All sorts of minor variations are seen when one takes into account the changes near the bank in their relation to the general stream flow.

On the opposite side, which was not visited, conditions are more radical, because the bank slopes on the average more gently and ridges of loosely piled rock extend out into the stream for little distances. Especially prominent were two basins that opened into the stream at several points and are known as the Big Bear Hole and the Little Bear Hole. They show, even from a distance, quiet water circling round and round. In the center of the stream the current is much broken by what are evidently huge rocks in the bed of the river.

After having watched the course of the current carefully and having measured as nearly as possible the velocity in midstream, the author felt that no salmon could successfully surmount the rapids there for any considerable distance. The water is so murky with sediment that one can not see the body of the fish even when the back fin breaks the surface, and one is forced to draw conclusions concerning the behavior of the salmon from that which has been observed on clear streams where the actions of the fish could be definitely followed by the eye. It seems altogether likely that salmon endeavoring to pass the rapids will dart from point to point, forcing their way through the brief spaces where they are compelled to subject themselves to the full current, and resting behind a rock or in an eddy, or at least seeking a place close to the bank where the current is retarded considerably. There is little doubt that in such places fish will hang until, summoning their energies for a new dash, they make the next point of rest, and will repeat the process until they have reached the top of the rapids. Since it is not possible to see the fish even through a relatively thin volume of water, it seems altogether likely that they are oblivious to the movements of the dip net as it sweeps through one of these resting places and scoops out a part of the group waiting there. While it is true that the most effective net fisherman has his net in the water only a fraction of the time, it seems probable that he secures a much larger percentage of the fish than has been estimated by various observers previously. Inasmuch as the fishermen are distributed fairly numerously along the west bank of the rapids, and inasmuch as the fish will necessarily take a considerable time to surmount the rapids even under the best of conditions, it seems likely that during the time in which dipping is being carried on

FIG. 1.—SALMON DIP-NETTING STATIONS, ABERCROMBIE CANYON, COPPER RIVER.

FIG. 2.—DIP-NETTING SALMON, ABERCROMBIE CANYON, COPPER RIVER.

the dip netters will get nearly all of the fish that are passing upstream on that side.

Some persons interviewed thought that many fish went upstream through the center. As an evidence of this they asserted positively that they had seen the back fins of the salmon breaking the surface far out and even at the center of the current. There is no reason to doubt this statement in so far as it rests upon an observation made, for the observers were careful and conscientious men, and in numerous instances, no doubt, they had seen the back fins of the salmon appear above the surface and disappear below it at considerable distances from the bank. On the other hand the inference drawn seems open to grave doubt. Let it be remembered that no one can follow the course of the fish even for a short distance after the fin has once passed below the surface of the water. Furthermore, in such cases the fin is in sight for a moment only, appearing and disappearing almost instantaneously. The author has often seen similar appearances in other places and has found them connected with conditions entirely different from those that were inferred in this case.

Salmon attempting to ascend an extended rapids against a powerful current make a dash through a stretch where they feel the full force of the stream, and if they are diverted from their path by some swerving of the current, or if they fail to select precisely the right direction to bring them under shelter before the energy of their dash has subsided, they are caught by the full force of the stream and carried downward. It is easy to interpret such conditions when one can follow the fish in water that is more or less transparent. Under the circumstances here it is evident that the direction of the fish can not be followed unless the fin is visible and the brief period in which it can be seen is no index whatever of the general movement of the fish. Under the conditions as they exist at present there is no doubt that a considerable number of fish ascend the stream along the east bank, resting in the large eddies referred to previously. Even if fishing on the west bank eliminates a considerable percentage of the run, the protection offered by the east bank will probably allow a goodly number of fish to make their way upstream unhindered, though there is no evidence at hand to indicate whether the majority of the fish choose the one bank or the other. It is not impossible that conditions at the base of the rapids tend to divert the major portion of the run to one bank rather than to the other. In such a case the results of leaving one bank unfished where the other is fished assiduously will vary from those stated under the assumption that the run is more or less equally divided between the two shores of the stream.

Of course, it is possible that the bed of the stream, by virtue of the large rocks in it, may have a more or less protected channel for the passage of the fish. But even in this case, the current will necessarily be more powerful along the bottom than it is at the sides near the surface, and there seems to be no reason to think that in this particular place conditions in the bed of the stream are exceptionally favorable for the ascent of the salmon; and unless they are more favorable than surface conditions would lead one to expect, salmon will hardly be able to use that path. So far as could be ascertained, conditions at the center, either in the surface or bottom waters, will be much the same at all stages of the stream. On the other hand, shore condi-

tions will vary much with the stage of water, and it may well be that one bank will be more advantageous for the fish at one level and the opposite shore at another water level. The situation deserves further study.

Unquestionably that stretch of water affords a most serious obstacle, and, indeed, the only serious obstacle which is found to the ascent of salmon in the Copper River. It doubtless delays them considerably, and repeated efforts may be required to carry the fish through the entire course of the rapids. Such a condition would exercise a significant influence on the success of the dip netting carried out there.

LONG LAKE.

This body of water, which lies close to the railroad and parallel with it, has been frequently mentioned as an important spawning ground for the salmon of the Copper River. Starting in on the outlet creek a mile or two below the lake, the party walked upstream in the water nearly as far as the lake itself. At that time (July 22) the stream was so small that it is doubtful if any red salmon could ascend it. The bottom was rocky in places and the passageway badly choked by logs and brush. The stream bed had an average width of possibly 6 or 7 feet, and the water averaged about 6 inches in depth. An abundance of fish food was noted, caddis-fly larvæ being common. Several small fish were stirred up that measured probably 4 or 5 inches in length and one Dolly Varden trout 8 inches long was seen distinctly. A single group of a few timid fish fry apparently working downstream seemed to be young silver salmon, but none of these could be captured. A deep, well-worn bear path at one point indicated that some animal was looking for the arrival of food fish.

At the lake a settler reported that the earliest run of salmon recorded previously was on July 28 some six or seven years ago. "About a million salmon," according to his estimate, used to enter the lake, but since the cannery had been established at the canyon hardly any fish had come up. The normal run here used to be between August 1 and early October. At one time in October he counted over a hundred salmon entering the lake within 10 minutes. In 1917 the first fish arrived on August 16. In that group, which played near the railroad trestle before passing out into the middle of the lake, there were 17 salmon according to actual count.

A motor boat in which to make a survey of the entire lake was secured from the settler. The water seems to be fairly deep everywhere, the shores going off steeply and having only insignificant stretches of gravel bottom in shallow water where spawning would be possible. The depth of the lake taken by line is said to vary from 60 to 100 feet. It is apparently fed by springs, and there are no permanent streams to carry silt into it. At the head of the lake was a small shallow area in which grayling were found building nests and apparently getting ready to spawn. At two other points there were gravel beds of insignificant size on which spawning would be possible. Certain places showed good evidence that salmon had spawned on this gravel in previous years. A few young salmon fry were seen. Most of these were silvers and a very few were red salmon

It is difficult to accept seriously any statement that the lake was visited under the best of conditions by a million fish. The total available spawning area for all kinds of salmon would not accommodate 2,500 fish, and unless the habits of this particular run are different from those recorded for salmon elsewhere, there are no other parts of the lake in which spawning could be carried out effectively. It is, of course, possible that some fish (not red salmon) may drop back into the outlet creek and spawn there, but the area available for this purpose is also relatively insignificant. All in all it was clear that Long Lake should not be considered as a significant spawning ground for salmon, and it seemed likely from the conditions indicated that the fish which spawned there were silver salmon rather than sockeyes.

For a small number of fish the lake would be a good spawning ground. It has a drainage basin of limited extent. There is no stream of any sort flowing into it, and at most the few rivulets that come from melting snow banks would be the only sources by which silt and débris could be introduced. Under these conditions the water is clear and the level of the lake is undoubtedly very stable, so that those eggs which are deposited have a good chance to develop properly. On the other hand enemies are common, as the lake is reported to be the best fishing ground for grayling that can be found in the entire region. As there are no considerable shallow areas and no plant growths to afford protection, all young fish must be readily subject to capture by the grayling, especially since the waters are so clear. This condition probably obtains throughout the entire open season.

CHITINA CREEK.

The creek which empties into the Copper River just below Chitina passes under the railroad track a few steps beyond the passenger station at that town and just short of the roundhouse. It flows down through the town of Chitina from two lakes in the valley a short distance above the town. As the railroad approaches the station it skirts a small lake into which the creek empties and from which a continuation of the stream connects it with the Copper River a couple of miles south. At that time (July 29) fish were jumping actively in the lake south of the track, where probably 300 to 500 fish were schooled. According to the statements of the railroad employees the salmon had been coming up for some time. The creek is very small, being only from 4 to 8 feet wide with an average depth of 6 to 10 inches. The stream passes through the town and is nearly blocked at several points. Above it the bed was full of drift and bowlders and the average drop in the stream, which was about 1 foot in 10, made it evidently difficult for the fish to work their way up. Some fish were seen in almost every pool along the course of the creek and they were working hard to get upstream despite the obstacles which the conditions presented. They were on the whole well colored and would have been ready to spawn in two weeks. Previous to this date there had been an abundant run of fish, for 200 were counted drying on racks at one point on the bank and other empty racks bore evidence of having been recently filled with fish that had been removed. Residents reported a good catch.

It is a quarter of a mile in a straight line and several times as far by the windings of the creek from the lake near the railroad station to the first lake in the valley above the town. This lake is about a quarter of a mile long and shallow. No salmon were seen and no evidences of their presence at any time were discovered. Salmon were traced up the creek something like one-half or two-thirds of the way to this lake. Some were found spawning at a point where a large cold spring emptied into the creek. In passing through a tract which has been cleared for farming purposes and which lies somewhat more than halfway from the town to the first lake, the bed of the creek is very badly filled up with débris and brush. It has been used as a dumping ground and a mass of brush and cuttings taken from the cleared land has been thrown into the creek, constituting an effectual barrier to the passage of the fish. It is evident that it would be impossible at the present time for salmon to ascend beyond this point. It was stated that previously they used to go up to the lake itself. Several schools of young salmon were seen in the creek, but in all no large number of them was found. A resident on one piece of land through which the creek passes stated positively that there were very many more fish there this year than last year and that everybody had enough fish for their purposes.

It is evident that unless some attention is paid to this stream by local authorities it will soon cease to be of any significance whatever as a resort for spawning fish. The clearing of the land and the filling of the channel, which is a convenient receptacle for any material to be disposed of, have limited the fish to a fraction of the territory which they probably utilized previously. Furthermore, on the bank of the lake which lies near the railroad track just below the town is a large oil tank from which, according to apparently reliable reports, drip and waste spread at times over large parts of the water surface. Evidence was readily found showing damage done to the life of the lake by this means. It is clear that while this might not interfere very much with the spawning of the salmon, especially when the water level was high enough to permit the spawning fish to pass promptly through the lake and up into the creek beyond the town, yet it would be a very serious condition for the young fish when they drop out of the creek soon after they emerge from the gravel in the spring and seek to find in the lake means of livelihood during the considerable period of growth before they turn downstream into the river on their trip to the sea. All in all this region, which serves at present as a good spawning ground for 1,000 to 2,000 fish and which yields probably a catch several times as large to natives and citizens for various purposes, is likely to be seriously depleted within a short time if indeed the run of salmon in it is not entirely destroyed.

LOWER KLUTINA RIVER.

The Klutina River is an exceedingly rapid stream for some distance above its junction with the Copper River at Copper Center. It shows almost a constant succession of rapids, and the bed contains many large rocks, so that it would be difficult to make any detailed study of the stream, but this is not important because its character evidently precludes the possibility of its being utilized as

a spawning place or even as a resting place for the salmon during migration. They can find opportunity to rest for a brief time behind rocks or in the small pools that recur practically everywhere in the course of the river, but once having entered the ascent of the stream they will not find it practicable to delay long or in considerable numbers until they reach what is known as the big eddy, which is an expansion of the river with a number of islands and several channels. It is located several miles from the outlet of the lake; between it and the lake the stream flows more gently and with unbroken water of considerable depth. There are also several eddies formed by expansions of the stream or by stretches of water lying behind projecting tongues of the bank. One of the most favorable is opposite the camp and about one-half mile below the actual entrance into the lake itself.

On the projecting shore, upstream from this eddy, is a large clearing with the remains of cabins, occupied by prospectors and miners originally, but since then utilized for various purposes. Salmon-drying racks and net racks as well as fish platforms and net stakes in the eddy indicate that this point has often been visited previously for the taking of salmon and their preparation. The activities in this line are said to have been carried out by Indians in part but most extensively by an outfit that fed dog trains here and at that time attempted to bar the river by stretching across it a fence of wire netting. The strength of the current and the amount of driftwood coming down promptly carried out the netting, but the efforts to take fish by nets set in the eddy are said to have been very successful.

During the time spent at that camp, fish were constantly jumping in the eddy on the opposite shore and occasionally in the water near the shore above and below the eddy. It seemed as though the red salmon gathered there to rest in their migration; they certainly were abundant, for on one occasion, in setting out a net only 50 feet long, two salmon were entangled in it before the entire net had left the boat. At another time one dozen fish were caught in an hour. They were all well-colored, fine, large fish and were measured carefully, examined, and utilized to obtain scales for future study.

The fish were jumping in this region, not only during the day but also during the night and to some extent along both shores of the river, so that migration was active at the period of the visit to this point.

SALMON CREEK ON LAKE KLUTINA.

About 1½ miles from the outlet of Lake Klutina on the southeast shore the stream known as Salmon Creek enters the lake. Its water is visible some little distance away from its mouth, which is partly hidden in low, boggy, and spruce-covered shores. The stream itself is clear and entirely free from glacial waters so that where it flows into the lake a transparent streak can be followed for some little distance before it mixes thoroughly with the milky-white waters of the lake itself.

From a distance of at least one-quarter mile, on approaching the inlet, a large brown bear was seen feeding on the shore. Alarmed by the approach of the party he scurried off into the forest, but a half-eaten salmon was found at the water's edge where he was first

seen. Bear trails led through the swamp in various directions, coming out to the shore in many places; in fact almost every little point or solid tuft of ground at the edge of the water had been utilized by bears as a feeding place. The tracks were visible in the mud, and the skeletons or parts of dead fish lay in abundance in the trail near the water's edge. While this was the only bear actually seen feeding on the creek, evidence seemed to indicate that a considerable number of these animals were in the habit of visiting the stream and feeding on the salmon.

Because of the statements made by residents, and especially by cannery men in Cordova, that the brown bear was the greatest enemy of the salmon and contributed "much more than the canneries" to the destruction of the fish, particular attention was paid to the problem here and at other points visited. It is certainly true that on visiting such a stream and looking over the banks one gets the impression that the bear has exacted a heavy toll from the spawning salmon.

On the other hand, when an actual count was made of the fish, it appeared that even considering each of the uncertain fragments as representing an entire fish that had been eaten, the total consumption was not very large in comparison with the number in the stream. Of even greater importance is the fact that practically all the fish seen on the shore were such as had been almost, if not entirely, spawned out and seemed to represent the half-dead fish which after spawning had floated up from the nests in the deeper pools and had been carried by the current near the shore where the bears could reach them. This statement should naturally not be interpreted as indicating that the bears never catch fish before spawning or during the period when they are only partly spawned out. What happens earlier in the season could not be definitely told by conditions at the time of the investigation, when the stream contained fish not yet ripe as well as those partly spawned out and many that were completely exhausted and were merely floating near the surface, making only an occasional movement and incapacitated to escape, but at that period the fish caught by the bears were almost exclusively spawned out. Furthermore, among the carcasses that could be identified, the majority of the fish on which the bears had fed were males. Indeed, many spent fish were picked up from the water without the least difficulty. They were the only ones that at that time came near the surface or banks of the stream, whereas the spawning fish stayed down on the nests in deeper water and were both shy and quick to evade any attempt at approach.

A large number of dead salmon were also seen fungused and marooned on the bottom in the broader lakelike portions of the outlet. Live salmon were found nest building and spawning at almost every suitable point in the course of the stream. The party walked up along the bank and through the bed of the creek for something over a mile. The stream flows over a bottom composed of coarse gravel and water-worn stones in an endless series of short meanders separated by little ripples that left a deeper pool about every 10 yards. In each of these pools from 20 to 30 red salmon were grouped together. The fish showed various stages of maturity from such as were hardly colored at all to those that were already half spent. Including those scattered along the shore there were more dead than

live fish and the dead fish were in every stage of disintegration. A conservative estimate of the fish seen in the course of the distance traversed would put the number of live fish at 3,500 and of dead fish at 5,000.

From the contour of the surrounding country it was evident that the creek extended for a long distance without any material change in character. The fish were as abundant at the end of the walk upstream as they were at the start, and it seems probable that the entire stream for several miles at least was equally favorable for spawning and equally well populated by the fish. All in all, the creek deserves its name and reputation as a fine spawning ground for red salmon. In the course of the trip one moderate sized grayling and one very young fish (kind undetermined) were seen. There were no schools of fry or fingerlings representing last year's spawning and no numbers of other fish that would be unfavorable to the development of the young salmon.

This shore of the main lake was followed as far as the center of the crescent. There was no other stream that possessed any beach outlet with enough water to float a salmon, and there were only two or three points where even a minimum inflow of water at this time of the year was detected. Evidently all fish that came to this section of the lake must spawn in this one creek. On the way to and from the creek mouth salmon were observed jumping in the open lake water. They were always relatively near the shore and were apparently following up the lake to the mouth of Salmon Creek. Jumping salmon were not observed at any point along the shore beyond the mouth of the creek, so far as the shore of the lake on that side was traversed, nor in the open lake away from the shore.

The configuration of the country was such that having studied the shore halfway along the southeast side, it was unnecessary to continue on that side up to the head of the lake. Beyond Salmon Creek there is evidently no other stream on the southeast shore which is large enough to be of significance in the problem being studied.

HEAD OF LAKE KLUTINA AND UPPER KLUTINA RIVER.

From camp, which was only half a mile along the shore from the mouth of Hallet River, numerous trips were made through the channels and sloughs at the head of the lake and up the Upper Klutina River itself. That the spawning grounds of the salmon were in proximity was evidenced by the number of dead salmon on the shore. A hundred such fish were counted within 200 yards. Many of the bodies had been partially eaten by bears, and bear tracks were abundant in the vicinity. Both at evening and during the first night salmon were seen and heard jumping near the camp, and a trip in the boat alongshore disclosed a small clearwater inlet with numerous living fish playing around, a few dead and spawned out floating on the water, and some nests, although not much of the available space had yet been occupied. A very small rivulet ran into this inlet, and the water was perfectly clear, being thus in sharp contrast with the milky water of the lake in general. The clear water ran out into the lake underneath the milky water, thus betraying its markedly lower temperature.

The guide reported that on August 19, 1917, when this region was examined previously, the lower part of the inlet, which at the time visited contained mixed water or at least milky water on the surface, was then entirely filled up by clear water, and salmon were seen spawning on the bottom. In paddling about in this region at one time, through an eddy of clear water stirred up by the oars, a single nest was seen on the bottom with ripe fish playing around it.

A trip up the Hallet River along the bank for a considerable distance showed that the water was very shallow and the channel subject evidently to frequent shifting; little or no evidence of fish was found. If the salmon ascend this stream, they must go for some distance, since conditions are entirely unfavorable for spawning in the region traversed, and also for a considerable distance farther—in fact, as far as the stream could be followed with the binoculars from the vantage point of a mountainside overhanging the valley.

On August 14 the gill net was put out in the bay between camp and the inlet just described. In an hour's fishing 24 female and 39 male red salmon were taken. The net was placed about 200 to 300 feet from the shore. The fish were mostly ripe, large, well nourished, and free from mutilation. These fish were examined, as was also a series picked up on the shore that represented salmon nearly or entirely spawned out. Although dead, they were reasonably fresh and in good condition. It is noteworthy that some of the dead females were not spawned out, as they still contained from 50 to 200 eggs.

The bluntly rounded southern end of Lake Klutina is indented by a considerable number of inlets or sloughs, some of which represent river outlets and others of which are blind indentations in the broad delta formed by the material brought down from the glaciers, in part by the Hallet, but much more largely by the Upper Klutina. One of these, lying farthest to the west and just at the point where the shore turns sharply toward the north, has already been described. The indentations were carefully examined, since they constitute most important spawning grounds for the salmon that visit this part of the lake. Their significance will be apparent from a brief statement of the conditions as found. The most westerly has already been described. Next to this, and about 250 yards farther on, is a clear-water inlet without visible inflow but apparently supplied by seepage water from the sides or bottom. It is approximately 5 feet deep near the mouth where it joins the lake. Large numbers of living and dead salmon were seen in the inlet or lying on the bottom.

This was, in fact, a most ideal spawning place, with good bottom, well protected by heavy timber on all sides. The irregular wedge-shaped area, gradually contracting as it penetrated into the forest, seemed to be not only thoroughly protected against storms but for some reason free from the floating timber that, driven on shore, formed a tangle just above the present lake level along most of its shore line. The majority of the living fish seen here were ripe, and fully as many lay around that were dead and spawned out as were living in the water. This inlet was about 50 feet wide at the mouth and preserved a depth of 3 to 5 feet almost to its head. Possibly it is an old river channel, but if so it has grown up so perfectly that no indication of its connection with present channels of the river could be detected.

About 200 yards farther west was a similar inlet, smaller in size, being only 15 feet in width and 2 to 3 feet in depth. The water became clear about 50 yards from the outlet. In this inlet, which is a small affair with a good gravel bottom and no visible inflow, lying just outside the mouth of the west branch of the Upper Klutina, several nests were observed, 25 or more dead fish lay around, and about half as many living fish were playing in the water.

A striking contrast with these conditions was afforded by a big slough with several long arms which was situated 100 yards farther on. It had a good gravel bottom, well cleaned off, with a width of about 75 feet, and the water was 3 to 5 feet deep. There was a very scanty inflow over a small beaver dam near the head. Much more plant growth was present than in the other inlets previously visited. Several ducks were seen feeding in the waters, and a couple of little fish darted away in front of the canoe. This slough was really a lateral pocket from the westernmost branch of the Upper Klutina River, which, in fact, empties into the lake jointly with it. This branch of the river was explored at a later date, and the account may be left here in order to continue a description of the series of inlets.

Turning again eastward along the rounded southern end of the lake, the next inlet proved to be another arm of the Klutina. In paddling up this arm for a considerable distance, some shallow lateral pockets were explored all of which proved to be filled with milky water and contained frequent patches of grass and brush. In these were seen no signs of salmon nor, indeed, of any other fish. This branch of the Klutina soon became very narrow, with brush projecting clear across the channel of the shallow stream, which increased in swiftness until further progress became impracticable.

Some 200 yards farther on another small arm of the Klutina, called the Third Channel, was encountered. After working up a few hundred yards without seeing any signs of fish whatever, the party was compelled to turn back because of obstructions. This is clearly an old and well-established channel of the river.

Nearly half a mile farther along the fourth channel was entered. It was broken up into numerous smaller winding channels, which were swift and shallow and which joined and separated at brief intervals. The variation in depth and the swiftness of the current made navigation exceedingly difficult. Small overflow ponds lay here and there on the flats, some still connected with the stream, others evidently filled at a higher stage and now separated from the channel by sand bars. A couple of small rocky islands separated this group of channels from the main stream of the Upper Klutina River, which lies almost against the mountain on the east side of the valley. This main river is broken into fragments by bars, some easily seen, and others lying just below the surface, not visible in the muddy water. This channel carried more water than all of those seen previously. In it the current was powerful, but relatively smooth. This branch of the river was followed up for a couple of miles without showing any evidence of the presence or movement of salmon. No streams emptying into it were found, and the bays and backwaters were all of them devoid of traces of salmon, either present

or in the past. No evidence whatever could be procured that the fish frequent this channel or use it as a means of ascent to small lakes connecting with this branch higher up near the glacier from which this stream originates.

At a later date a trip was made up the west branch of the Klutina. The banks of this branch were well marked and firm. They are lined by spruces, which for a considerable distance are large and thickly set. The water in the channel is relatively deep, and all features combine to show that it is an old channel which probably at some recent time carried much more of the flow of the stream than at present. The channel is tortuous, but follows in general the base of the mountains on the west side of the Upper Klutina valley. From this to the present main channel of the river, which lies on the east side of the valley, the ground is nearly flat, composed of glacial silt, and intersected by occasional cross-channels. Small lakes, communicating with one branch or the other, lie on this flat, and are surrounded in places by alder thickets that at that time were not entirely out of water. Along the west side trees are more numerous and larger and the land has evidently attained more stable conditions than exist on the main channel on the east side of the valley.

The old west channel is frequently barred by beaver dams, which in some places are so numerous as to have formed a labyrinth of channels in which it is difficult to find one's way. In places successive dams were not more than 10 or 12 feet apart, and while some of them were only a foot in height, one was found which represented a vertical height of between 4 and 5 feet. Various ponds or small lakes that lay on the right or left of this channel were examined, but no traces of spawning fish or of past spawning activities were found. Most of these ponds owed their origin evidently to beaver dams, and in some cases their maintenance was very clearly due to such obstructions. They were adequately supplied with vegetation, but were evidently not frequented by many fish. Field notes indicate that one grayling about 10 inches long was observed, but no other fish of any size or kind was seen, until on the return trip, as the boat was lifted over one beaver dam, a female red salmon was seen wriggling up the face of the dam. There was not opportunity to investigate all of the lakes in this upper valley or to follow all of the small branches that led off from the river, but the stream was evidently not used at this time by any conspicuous body of fish, or something of them should surely have been seen. Furthermore, no evidence was found of the previous activity of salmon in this region, whereas in other places such evidence was present even at times when the fish themselves could not be found. The conclusion was reached, accordingly, that this region was not one in which much spawning took place. At the time of the trip the water was slightly milky. The guide reported that in 1917 this branch carried only clear water. The point was found at which the water was contaminated by a small quantity flowing in from the opposite side of the plain, and above the point where this material was received the stream was perfectly clear. It would seem that this branch of the Klutina, with its lakes and gravel bed, might afford good spawning places for considerable numbers of fish.

ST. ANNE LAKE.

St. Anne Lake, which lies at the head of the stream bearing the same name, is surrounded by low banks, and at the lower end especially is bordered by swampy and boggy shores. It has the form of a long oval, being 5 or 6 miles in maximum length and a mile or a little more in width.

The lake is very shallow at the lower end, being nowhere more than 4 or 5 feet in depth and having for the most part a depth of less than 3 feet. The bottom is richly overgrown with water plants, among which the Charas are conspicuous. At various points growths of different types reach to the surface, making veritable reefs of vegetation that are favorite feeding grounds for myriads of waterfowl. In the shallow portion of the lake fish are very abundant. Large ling cod lay on the bottom within easy reach and could be gaffed without difficulty. Moderate-sized whitefish played about in the open water at middle depth and schools of small fish, probably whitefish, darted away rapidly as the canoe approached the point where they were resting.

The water swarmed with various aquatic organisms. Plankton animals and plants were so abundant as to be conspicuous to the naked eye and on one of the days (Aug. 21) the lake was covered with a delicate water bloom produced by a minute unicellular alga (*desmid*). By reason of the aquatic life characterized above, this lake is by all odds the most suitable place seen on the trip for the development of young fish.

A single dead king salmon was found floating in the lower section of the lake in front of the knoll on which the camp was located. Several red salmon, nearly ripe, were seen in the outlet creek only a few yards below the lake, but otherwise no trace was found of any kind of salmon in all the stay on the lake. The party rowed along the west shore as far as the head of the lake. The net was put out in deep water at two points in the north half of the lake and caught only a number of large suckers which were about ready to spawn. The east shore seems to be largely, if not exclusively, formed by banks of glacial clay without rocks or stones. The west bank is stony, being made up of angular fragments and not composed of rounded or water-worn gravels. Along the stony west shore search was made for evidence of salmon nests, either new or old, and for salmon fry as well as for spawned-out fish.

It is perhaps not strange that young salmon were not found, because at this period it is likely that any which might have been present earlier in the year would already have started on their migration downstream to salt water. But despite the fact that fish nearly ready to spawn were seen so near the lake in the outlet stream there was no trace of the fish themselves in the lake and no evidence of their having utilized the territory for spawning purposes previously.

The water of the lake must produce immensely large quantities of young organisms which serve for food of the salmon fry. Undoubtedly these are carried down the outlet stream in considerable numbers and serve in that way to maintain the fry that are hatched in St. Anne Creek.

This lake is deserving of further study, and in case it is proposed to set aside any reservations in that section of Alaska, St. Anne Lake should certainly be included because of its remarkable fitness for supporting fish life.

SUMMARY.

Copper River and its tributaries may readily be subdivided into a small number of regions which differ distinctly in character and probable relation to the spawning of the salmon that visit the region.

1. A group of small tributaries flowing into the river on the west side between the mouth and the town of Chitina.—These streams are all very short, rather turbulent, and not supplied with lakes to which salmon can ascend for spawning. While lower reaches of these streams may be utilized by silvers that come late, there is good reason to think that they play no part in the red salmon production of the river.

2. Chitina Creek, with its small lakes.—This creek belongs in a sense to the series of short streams entering the lower river from the west, but it differs from all the rest in having attached to it a series of permanent lakes that are accessible.

3. A series of three tributaries of some size which enter from the west, and which possess conspicuous lakes.—These are the Tonsina, the Klutina, and the Tazlina Rivers. Tonsina Lake was not visited, but Klutina and Tazlina Lakes and Rivers, with their tributaries were studied in detail. They constitute undoubtedly the most important spawning grounds visited, and perhaps the most important connected with the Copper River system.

4. The upper Copper River, with its tributaries, the Gulkana, the Gakona, the Mentasta, and others, which lie north of Copper Center.—There are many lakes on these tributaries, and it is likely that in normal seasons salmon are abundant in this region. This territory was not visited.

5. The Chitina River, with its tributaries.—In this region only Long Lake was visited, and it does not seem to deserve the merit as a spawning place for salmon that has been attributed to it. Many reports were heard of salmon being abundant in various subordinate streams and lakes connected with the Chitina. Some of these reports were very definite. One of them, which was current later than the visit to that region, was investigated by J. E. Most, superintendent of the cannery at Abercrombie. The account concerned lakes on clear streams that run into the Neena and ultimately into the Nizina. According to Mr. Most's statements, the lakes are small and are fed by numerous clear streams, all of which contain some salmon. His observations led him to think that there were some 3,000 fish in this vicinity at the time of his visit, about the middle of August.

6. The tributaries of Copper River on the east between its mouth and Chitina.—Clear Creek has already been discussed. It is a small stream, but the only one in that stretch which was reported to be significant as a spawning ground for salmon. The Bremner, which is the largest stream on the east side of the river in this stretch, is said to carry a good many salmon, but opportunity was not given to visit it nor any of the other streams in that vicinity.

7. Lake Klutina.—This is a most important spawning ground for the red salmon. Salmon Creek, on the southeast shore, several inlets at the head of the lake, and St. Anne Creek, at the northwest angle, form the actual spawning territory. The red salmon were well advanced in spawning on Salmon Creek August 6, on St. Anne Creek August 10, and at the head of the lake a week later. Spawning had

practically ceased in St. Anne Creek on August 19. This indicates that the Lake Klutina salmon probably come from the early run in the Copper River.

8. Lake Tazlina.—This lake affords no opportunities for red salmon to spawn apart from the Nelchina and Mendeltna Rivers, which are said to carry salmon lakes on their courses some distance beyond Lake Tazlina. Red salmon not yet entirely ripe were entering Lake Tazlina and ascending the Mendeltna River on August 29, indicating that this region is supplied by the late run in Copper River.

9. Red salmon reach both Lake Klutina and Lake Tazlina in splendid condition. Most of them are not mutilated at all, and even the few that show injuries are only slightly affected.

SPECIAL INVESTIGATION OF SALMON FISHERY IN CENTRAL AND WESTERN ALASKA.

By C. H. Gilbert and Henry O'Malley.

LETTER OF TRANSMITTAL.

September 20, 1919.

The Commissioner of Fisheries,
Washington, D. C.

We inclose herewith a report on the salmon fisheries of central and western Alaska, based on our observations in the field during the past summer, taken in connection with the history of the district in former years.

We have stated at length our conviction that the industry has now reached a critical period, in which the salmon supply of Alaska is threatened with virtual extinction, unless a radically new administrative policy be substituted for the one now in force.

The crisis is made more acute by the exhaustion of the salmon fisheries in Puget Sound, due to prolonged overfishing in the face of persistent warnings like the one we here present concerning Alaska. The numerous well-equipped canneries of this southern district are confronted by the necessity of suspending operations in the near future. Their supplies and machinery will become available for the Alaska field, which they will certainly invade wherever promising sites can be obtained. Unless effective governmental control can be secured to prevent further invasion of a district which already suffers the evil results of unrestricted competition, certain disaster will befall the salmon fisheries of Alaska.

Respectfully submitted.

C. H. Gilbert, *Special Assistant.*
Henry O'Malley, *Field Assistant.*

GENERAL SITUATION AND SUGGESTED REMEDIES.

During the season of 1919, the writers visited the Copper River, Cook Inlet, Bristol Bay, Ikatan and King Cove, the Karluk River, and Kodiak. With the exception of Chignik, which was not visited, these localities comprise all the most important fishing districts in central and western Alaska. They form the home par excellence of the most important species of Alaska salmon, the sockeye or red salmon; and they produce some 90 per cent of the entire Alaska sockeye pack. Also, they are wholly dependent on this species. In central Alaska, it is true, not unimportant packs of pinks and chums are now put up, but it remains true of central Alaska, as it does to an even greater extent of western Alaska, that the continued existence of the salmon industry is dependent on the preservation and maintenance of the red-salmon runs.

These have been drawn on heavily since the earliest days of the salmon industry in Alaska. The red salmon alone was then sought as the only species having any considerable commercial value. Other species were taken incidentally or to fill out the pack where red salmon in a given year were not to be obtained in adequate numbers. A market for chums and pinks was developed progressively but slowly with later years. Not until 1911 did the combined packs of all the other species slightly exceed that of the red salmon alone.

With this species at first the only salmon in demand, it is natural that the streams of central and western Alaska were among the earliest exploited. Canneries entered the field in 1882, when one was constructed on the Kussilof River in Cook Inlet and another on the Karluk River, Kodiak Island. Others followed in rapid succession. In 1899, 25 canneries were operated in central and western Alaska: The Copper River supported 4; Cook Inlet, 2; the Karluk River, 6; Alitak, 2; Afognak Island, 2; Chignik, 3; Orzenoi, 1; Thin Point, 1; and Nushagak, 4. In many of these localities, salteries had been in operation for a number of years before the canneries were built. Thus the principal red-salmon districts of central and western Alaska were already occupied at that date and have been assiduously fished for 30 years or more. The question of how well the sockeye colonies have sustained the exactions of the commercial fisheries during this long term of years is pertinent.

The subject is complicated and difficult to handle. Each stream in this vast area has its own wholly independent run of fish and has had its individual history. One stream may have been overfished to the point of exhaustion, while others in the same district may have maintained their runs unimpaired. So long as undeveloped territory remains and may be gradually drawn on, the total or mass statistics from a given district give no answer to the question of depletion. Nothing short of individual stream statistics are adequate, and even these must extend over a term of years, during which the manner of fishing and the amount of fishing gear employed each year are accurately given. Unfortunately, no such statistics are published and available, yet they would form the essential foundation for any well-considered scheme of conservation. Without such a body of statistics, legislation to protect and maintain the fisheries must be a groping in the dark. The Bureau of Fisheries should at once proceed to gather annually, under a skilled statistician, a well-planned body of data, referring where possible to individual streams. These should be collated in tabular form, digested, and published.

The preservation of the salmon supply to the rivers of Alaska concerns most vitally the body of consumers which constitute the general public. It is contrary to their interests that the fisheries be ruthlessly exploited and an important source of highly valuable food be placed in jeopardy, greatly diminished, and in time totally destroyed. The importance of sea foods will increase with the years, as grazing lands grow more and more restricted and flocks and herds continue to diminish. Yet now, in a period of comparative abundance, through sheer heedlessness and childish improvidence, this country is in danger of permitting the virtual destruction of the most important sea food it posesses—one which the ocean provides without cost and brings to its very doors.

The trend of events, at least, should be ascertained and an opportunity given wisely to safeguard paramount interests before irretrievable harm has been done. To this end it is essential that wherever possible stream statistics be prepared and that they be made public year by year. It will then be possible to learn how well the public trust is being administered. Should such statistics prove a progressive depletion of the salmon supply in any or in all districts, it is to be hoped public sentiment will be aroused and would find expression, demanding adequate protective legislation.

There has been no time in the history of the industry when precautionary measures have been so imperatively demanded as at the present. Development in the early days was often delayed and checked by the low price of the canned product and the ease with which the market could be overstocked. But during the later years, and especially since the beginning of the Great War, with unlimited demand for canned salmon and unheard-of prices prevailing for all the grades, there has been an unexampled expansion of the business. Whereas, in 1914 there were 82 canneries operating throughout Alaska, in 1918 the number had increased to 135. Everywhere, capital was seeking new cannery sites. Competition for the existing supplies of salmon was greater than ever before. New fields were entered where such could be found. But for the most part, the old fields were further invaded, although they were already fully occupied and carried no reserve supplies that could safely be spared. With the price of raw fish greatly advanced, the fishermen became more eager. They could afford to carry on their operations later in the season when the run was at the ebb, and constantly they gleaned more closely. No one can doubt that larger proportions of the spawning runs during this period have been captured for commercial uses, while smaller and smaller contingents have been able to win their way to the spawning grounds, there to make necessary provision for all future runs. It has been and still is a situation full of danger.

Even before the recent startling expansion of the industry, all disinterested observers held that in central and western Alaska a safe level of production had been reached, if indeed in many localities it had not already been passed.

Does anyone doubt that the wonderful Karluk River has suffered impoverishment since the days when it was easily able to produce year after year without interruption packs of 150,000 to 200,000 cases of red salmon? A comparison of the early days with the average packs of the last years is convincing that, whether or not on the Karluk bad is now giving place to worse, the river is consistently on a lower level of production than formerly. It is as though a wheat field should be held down to half its normal yield because the seed was begrudged.

Is the Copper River run not rightly considered in a precarious condition with adequate remedial measures not yet in sight? And are there not poor prospects ahead, now that fierce competition recently has been permitted for the small but highly productive red-salmon streams in Olga Bay? The Chignik has also been a wonderful stream and is still a valuable property despite the abuses to which it has been long subject. But does anyone believe it could stand the further drain of sharp rivalry which may at any time accompany the advent of an additional cannery?

Have not Ikatan and Morzhovoi Bay already suffered with six canneries contending with purse seines and traps for their not unlimited supply?

Mention need only be made of the formerly productive stream that enters Nelson Lagoon; and of the Bear River and Sandy River, which formed the main dependence of the canneries at Port Moller and in Herendeen Bay. Everyone knows they are far along the road

toward depletion, even though they may exhibit an occasional flare-up into a season of greater activity.

These are all clear-cut cases of overfishing with the resultant partial destruction of the runs of fish. And the end is not yet. So long as the high price of canned salmon continues, be assured that aggressive capital will seek an opening. Wherever a run of any size remains and may be further exploited, or wherever apparently an opportunity presents itself to force with profit an entrance into a field already overdeveloped, this will be done, and invariably the result will be a sharper rivalry for fish and a further decline in the run.

It is customary in these discussions to lay the responsibility for depletion at the doors of the canners, and to criticize them sharply for their rapacity. Something can be urged, doubtless, for this point of view; especially in the earlier days was this true when competition was in its infancy and fish were to be had for the taking, yet nevertheless streams were barricaded to prevent the ascent of the salmon, and other practices were indulged which constituted a cut-throat policy, foolishly and needlessly adopted.

But despite all this, the responsibility has rested from the beginning and now rests fairly and squarely on the shoulders of the Congress and the general public. The present administration of the fisheries appears based on the expectation that men will hold back their hands where a further profit can be made. It is witless to expect them to do so. The administration of public affairs can not be made to depend for success on men's voluntarily foregoing a profit. There are those, doubtless, who would relinquish private gain in the public interest, but it need not be contended that they are in the majority. And whereas it might appear that in the salmon business private interests would counsel moderation in the hope of securing the perpetuation and the permanency of the industry, such in fact is not the case. It would boot them nothing to permit most liberal numbers of salmon to escape their nets. So long as the public throws this field open to unrestricted competition, and so long as there results keen rivalry for every fish that swims, no individual canner can accomplish anything toward the protection of the streams. Whatever he spares for spawning purposes, his competitors will thankfully accept and place in cans. He is powerless to conserve either the public interest, or even—should he be sufficiently enlightened to see it—his own private interests, by listening to any counsels of moderation. If fishing grounds or fishing rights could be leased or assigned, and property rights acquired which would become valueless should the fishing greatly decline, cooperation with the authorities to preserve the fisheries could confidently be counted on. But so long as the present policy is maintained, and the canners have only what they can seize and can hold with every man's hand against them, there can be but one final outcome. Total exhaustion of the fisheries will occur; if not to-morrow, then the day after.

It can not be too often nor too strenuously insisted on that the dangers which confront the Alaska salmon industry are inherent in the very plan which the Congress has adopted for its administration. The only effective remedy lies in altering the groundwork of this plan, in treating the fishery resources in practice as well as in theory as the property of the public, and in administering them in the inter-

ests of the public rather than apparently in the interests of those who seek to exploit them.

They could be so handled as to insure their permanency and yet leave their operation in private hands. Treat the canneries as exercising quasipublic functions. License them to operate within restricted limits and on a specified scale, neither of these to be modified without direct authorization. Let no more operate within a given field than can do so while still maintaining the run at its *maximum of production.* Produce readjustments as these are shown necessary. Permit further expansion wherever evidence shows that this can safely be done. Restrict the output further wherever the danger point is approached. Permit all the salmon to be taken for commercial purposes that can with certainty be spared, but maintain a constant safety factor in favor of the spawning beds. *Maintain the runs at their maximum of production.* The salmon that could safely be spared from such runs would be vastly more than the utmost gleanings when depletion has occurred. Whenever restriction of the output becomes necessary, recognize the equity of the operators in that region as soon as the policy adopted shall again permit a degree of expansion. In this manner, the packers would cooperate with the Government under such conditions that it would be to their interests, equally with those of the public, to conserve the runs of salmon.

It may be urged that however meritorious such a plan might appear if the industry were in its infancy, it would be wholly impracticable to apply it under conditions as they now exist. But if the principle be once accepted, work can gradually be directed in the desired direction with immediate benefit to the situation. The present laws can be modified so as to diminish predatory competition. It can be required that existing canneries shall secure a license to operate in specified territory with a given amount and kind of gear. It should be discretionary with the Secretary of Commerce to license or refuse to license new canneries, or to permit or refuse to permit further expansion on the part of those already operating. And if on full investigation it should appear that any region is being dangerously drawn on, the Secretary should have authority to curtail production to any necessary extent. At present his jurisdiction covers only the streams themselves and a narrowly limited area about their mouths. But in many districts the harm is caused by excessive fishing in salt-water channels and in other restricted bodies of water which form the approaches to the streams.

Provision should be made in the laws that fishery sites can be licensed under suitable conditions, and that property rights vest in such sites under prescribed regulations. The nature and the amount of gear that may be operated on such site should be specified in the license. They should include trap locations, set-net and stake-net locations, fish-wheel locations, and seining beaches. Unless certain conditions were met these locations should revert to the public; otherwise they should be the property of the licensees so long as they could be operated without detriment to the salmon supply. But it should be within the discretion of the Secretary to limit or entirely to suspend the use of any location when such course should appear necessary.

Some of these provisions are already in force in the States of Oregon and Washington, where the discretionary power lodged in the

Commissioner of Fisheries exceeds that conferred on the Secretary of Commerce.

Further improvements can be made in the Alaskan field by making more adequate provision for the enforcement of the laws. Not only are our fishery statutes now pitifully inadequate, but they are unusually and unnecessarily made difficult of enforcement. The Commissioner of the State of Washington and those authorized by him exercise the power to arrest violators of the fishing ordinances, and they can seize any fishing appliance, including boats, traps, nets, and fish wheels, used in violation of the provisions of the act. But the agents of the Bureau, intrusted with the enforcement of the Alaska laws, have neither power to arrest nor authority to seize illegal gear. If it had been deliberately planned to hamper them in the interests of violators of the laws, it could not have been done more effectually.

BRISTOL BAY AND RED-SALMON RUN OF 1919.

The season of 1919 has proved the most complete failure in the history of Bristol Bay. Not only was the run smaller than ever before chronicled, but it was almost equally deficient in all the streams of the district. This has usually not been the case heretofore. The poor Nushagak run of 1907 was accompanied by fully average packs on the Kvichak and the other streams of the east side of the bay. In 1911 there was a poor Nushagak run and also a rather poor pack on the Naknek-Kvichak, but the Ugaguk had the largest pack ever made to that date. The Nushagak was far below average in 1912 and the other rivers all well ahead of all previous records. Only the Kvichak was deficient in 1915 and only the Nushagak in 1916.

From this it appears that the runs have varied independently of one another, thus favoring the assumption that in each instance the cause of failure was local in its nature, and not general. But in 1919 the situation seems different. The decrease in numbers of red salmon was marked, almost without exception, throughout central and western Alaska. Throughout the red-salmon district a marked deficiency was shown, which culminated in Bristol Bay. To account for this, it seems necessary to assume some widely distributed agency, which probably operated throughout these districts during the life of the salmon in the sea. It appears impossible to conceive that there should have been such a wide coincidence in unfavorable local conditions as would be required to explain the occurrence.

The run of 1919, in all the affected areas, was derived in part from the brood of 1915, but more largely from the brood of 1914. So far as is indicated by the pack of 1914, no cause can be assigned for the 1919 shortage. The pack was near its maximum in every Bristol Bay river except the Ugashik. If the four-year period and the season of 1915 be considered, a better case can be made out; for the Kvichak-Naknek pack of 1915 was reduced nearly to half that for the preceding three years; and although the Nushagak yield of 1915 was above the average, the escape to the spawning grounds, tallied at the Wood River weir, was the smallest ever reported. However, in 1915, both the Ugaguk and the Ugashik made favorable records, and

when it is considered that throughout this district the red salmon mainly mature at 5 rather than at 4 years of age, the improbability is manifest of explaining the shortage of 1919 by anything which occurred in 1915. The question whether in general the Bristol Bay streams give evidence of overfishing must now be considered.

HAS THE KVICHAK-NAKNEK DISTRICT BEEN OVERFISHED?

There is an unbroken series of pack statistics for the Nushagak River, reaching back to 1893, and for each of the other rivers of Bristol Bay since 1904. Some allowance must be made for a certain degree of inaccuracy, because fish were in some measure reported in favor of the district in which they were packed, regardless of where they were captured. No attempt is made to disentangle the Kvichak-Naknek complex, for the fishery is conducted to a large extent in the open off the mouth of the Naknek River and farther to the south, and contains Naknek and Kvichak fish in unknown proportions. This is equally true at both the Ugaguk and the Ugashik Rivers, for the great Kvichak migration sweeps past the mouths of these rivers, and fishing in these cases also is partly done in the open. It can not be said then that stream statistics for the eastern shore of Bristol Bay are wholly reliable, the element of doubt increasing as the mouth of the Kvichak is approached. The three rivers are very similar in their lower courses, with wide stream beds at high tide, choked with sediment; and at low water having extensively exposed sand and mud flats with greatly restricted channels. Fishing has always been freely permitted, practically without restriction, in all these streams, and while the statistics do not of themselves give reliable data, there are probably few who will assert, and fewer yet who believe, that these rivers now carry the body of salmon they formerly produced.

But in spite of inaccuracies, which detract from their value as stream statistics, they constitute a highly valuable record. Extending as they do over a period of 15 years, during all of which intensive fishing has been in progress, it would seem they should furnish unequivocal evidence of general serious depletion, if such had occurred. Had the manner of fishing and the amount of fishing gear employed remained relatively constant during this period, most valuable deductions could have been drawn. But the amount of gear employed has more than doubled and the fishing grounds have been pushed farther and farther into the open bay. What the effect of these changes has been must remain in some degree a matter of speculation. The Ugaguk responded to the more intensive fishing in 1911 and the Kvichak-Naknek in 1912, with greatly increased outputs; and these were maintained at the higher level for seven successive years, with the single exception of 1915, which was a partial failure on the Kvichak. The Kvichak-Naknek produced in 1912 nearly 14,000,000 red salmon, whereas 9,500,000 had been the largest number previously obtained during any year. Approximately the same number were captured the following year in 1913. From the eggs that were furnished in these two years of increased pack there resulted the run of 1917, when the Kvichak-Naknek yielded over 15,500,000 red salmon. The fact that a largely increased pack was thus possible, and that it could be maintained without serious interruption into the second cycle, when the effects

of the increased pack should become apparent, indicates that these rivers had not been fished to their full capacity prior to 1911 and 1912. It seems clear that more than 9,500,000 fish could be spared from the spawning beds without imperiling the run. But it does *not* indicate that the new level of production is a safe one, and can be maintained indefinitely. What could be safely spared in excess of 9,500,000 fish may have been taken, and a considerable number in addition. The new level has not been arrived at through any reasonable process. There was no knowledge of the situation which warranted such increase with any assurance it would not be fatal to the future runs. No precautions whatever were taken in the matter. Everything was haphazard, in accordance with the customary policy. All the fish which could be caught were taken without any heed to the future. It was known that it was impossible to catch them all, and it was vaguely hoped—if the matter was given thought at all—that, whatever be done, enough would escape to keep the run going. Fishing was conducted without limitations of any kind. The amount of gear was limited only by what could be profitably employed. Fishing was permitted in all the rivers as well as in the open bay. There was no close season to afford needed protection. Such has been and still is the policy. If a new method of fishing could now be applied which would make it possible to capture 20,000,000 fish from the Kvichak, the 20,000,000 fish would be cheerfully captured annually for five years until returns would be had in the next cycle of years, and then the damage would be appraised.

Fear that the danger point may have been reached on the Kvichak-Naknek is based on the fact that all efforts that have been made to increase the yield during the last seven years have been without result. Fully one-third more gear has been used in subsequent years than was used in 1912, and the only result has been to divide the fish more finely among a larger number of fishermen. Each net averages for the season a smaller number of fish, and the grand total is not increased. Such a result always indicates dangerous ground. It usually means that the use of increased quantities of gear is necessary in order to maintain the pack at the high level which it has once reached. In most cases a reduction to the earlier number of gill nets would entail a marked decline in the pack, showing that the total run of fish has suffered a reduction. Do the packers in the Kvichak-Naknek district believe that they could reduce their boats and nets to the numbers employed in 1912 and still continue to catch 14,000,000 or 15,000,000 red salmon in a season? If they maintain that they could do so, it seems strange indeed that they continue to incur this enormous additional expense each year in the certainty that it brings no returns. If the present number of nets is, on the contrary, essential, it means that each year there is a closer and closer gleaning from the spawning run in order to maintain the pack, and it means, furthermore, that the spawning run is already so greatly reduced that with the utmost efforts no considerable contribution can be secured from it.

This must be considered a dangerous situation, which can not continue without finally producing a greatly diminished run of fish to these rivers. It is not known what is the least number of spawning fish which will keep up a run to full size in any district, but such a minimum would vary widely in different years. Some seasons are far less favorable than others, both on the spawning beds in the lakes,

where the fingerlings live for one or two or three years, and in the sea. The number of spawning fish which would be adequate in favorable years, it must be recognized, would fail utterly to produce a run when the eggs, the fingerlings, and the growing fish in the sea had been exposed to unusually severe conditions and to more formidable attacks from their innumerable enemies. This is not unsupported theory. It is a necessary deduction from all the observations and all the experiences of those who have studied the sequence of the seasons in the fisheries.

A safety factor on the spawning beds is for this reason essential. Unfavorable seasons come without warning. They may be scattered, with wide intervals between, or two or more may come in quick succession. Unless there is spared each year for spawning purposes a number materially greater than are ordinarily sufficient, unfavorable seasons will declare themselves as failures which otherwise would have been saved by what in ordinary seasons constitutes an excess production of young. Such excess production must be maintained in order to be safe.

When increase of gear fails to produce material increase of pack there is danger that the safety factor has been abolished, if indeed no worse has been done. On the Kvichak-Naknek the 1917 yield of nearly 16,000,000 fish does not demonstrate that 15,000,000 could safely be taken in 1912. Other river basins have been watched during the progress of depletion. The sequence of events is always the same. Decreased production is accomplished by increase of gear. Fluctuations in the seasons become more pronounced. Good seasons still appear in which nearly maximum packs are made. But the poor seasons become more numerous When poor seasons appear no attempt is made to compensate by fishing less closely. On the contrary, efforts are redoubled to put up the full pack. The poorer years strike constantly lower levels, until it is apparent to all that serious depletion has occurred.

It can not be affirmed with certainty that the extremely poor season of 1919 has been due to a combination of overclose gleaning and of unfavorable general conditions, but it is believed that such has been the case. The year in any event might have been one of less than average yield, but the extent of the disaster would have been mitigated if a generous safety factor had been hitherto provided. The result of the year can not be foretold. The escape to the spawning beds must have been far below the average of recent years. It may have fallen below the minimum which is necessary to keep up the run even in favorable years. If so, the results will be serious in 1923 and 1924—bad even if the general conditions meanwhile prove propitious, far worse should they again prove unfavorable. Bad years more certainly reproduce themselves when spawning has been dangerously reduced.

The dangers of the situation with the present scale of operations continued have been pointed out, but on the Kvichak-Naknek there is danger of further increase. The region is recognized as the last great stronghold of the red salmon, the greatest producer in the world. Other canneries continue to appear; all are likely to increase their scale of operations; more gill nets will constantly be employed The prospects are unfavorable unless restrictions are imposed while yet there is time.

NUSHAGAK RIVER AND WOOD RIVER CENSUS.[a]

The Nushagak River has had a different history from that of the Kvichak and the smaller rivers which enter along the eastern shore of Bristol Bay. It was the first to be exploited and very early reached its maximum of production. The five years from 1900 to 1904 produced a slightly greater yield than the succeeding five, from 1905 to 1909. From 1910–1914 there was a material reduction of about 3,000,000 fish below the preceding period, and the five-year period which came to a close with 1919 shows approximately the same reduction. Yet during these periods there has been great increase in gear and a complete shifting of the fishing grounds to the channels outside Ekuk. Not only has increased fishing produced no increased returns, it has been accompanied by a small but unmistakable falling off in the pack. To this extent the situation on the Nushagak is more disquieting than on the Kvichak.

The decreased packs on the Nushagak, as seen in five-year periods, are due to the more frequent appearance of poor years. From 1900 to 1904 the poorest yield of any year was 4,125,000, which was not far below the average of the last two periods. From 1905 to 1909 the poorest yield during one year was 2,500,000. From 1910 to 1914 there was one year with less than 4,000,000 and one with less than 3,000,000; while in 1915 to 1919 there is one year with less than 4,000,000 and another probably with not to exceed 2,000,000—the latter certainly the smallest yield in 20 years, despite the enormously increased gear.

No one can doubt that there is here evidence of close gleaning from an early period, with the percentage of escape reduced to smaller dimensions and with little provision made for any safety factor. When in any stream the crests of the pack grow lower and the troughs deeper, retrenchment is called for. It is our belief that this condition is now declaring itself on the Nushagak.

The Wood River census of salmon which have escaped the commercial fisheries and are about to enter the spawning area of the river has been taken annually since 1908, with the exception of 1914. The actual number of fish escaping and the proportion these bear to the total run have varied widely during these years. Omitting from consideration the year 1908 and making allowance for an escape, of which there is no record in the Nushagak, the Igushik, and the Snake, the percentages of escape may vary approximately from 7 to 25, with an average perhaps in the neighborhood of 15 per cent. It is this 15 per cent only which would be subject to further inroads resulting from increase in amount of fishing gear. As the spawning reserve grows less and less, the capture of any considerable part of it becomes more and more difficult by open fishing of the kind employed at Nushagak. Some amount of escape is nearly always provided by adverse weather conditions, which usually slow up fishing at some time during the season and may even cause its virtual suspension for a short period. In addition a few fish pass around and through the forest of nets, impossible as that may appear, and some pass through the nets themselves. Many show net marks, indicating the manner of their escape, and many others must pass through the meshes unscored; for the average size of the fish captured in the upper bay, or reaching the weir at the foot of Lake Aleknagik, is much below the

[a] Upon recommendation of Dr. C. H. Gilbert, it has been decided to discontinue the Wood River census. See p. 33.

average for the fish captured in the outer bay. Where thus selected for their small size there will be more four than five year fish and more females than males. The latter may present an added source of danger, for if in the escape females largely predominate they may be unable to find males with which to pair, and their eggs may remain sterile. There are no observations on the spawning grounds which cover this point. It is possible that the male remains active for a longer period and will mate repeatedly, but it is not known that such is the case.

The escape through nets must present a fairly constant factor, but the amount of escape attendant on unfavorable fishing weather varies widely with the season. Some years are much more conducive to close gleaning than others. In 1915 the commercial capture was above the average, amounting to more than 5,500,000 fish; but the escape of less than 260,000 fish was the smallest then reported. The cannery pack of 1917 was practically the same as in 1915, but the escapement in 1917 was four times as great; in 1916 the escapement was nearly twice as great, although the commercial yield in 1916 was only about three-fifths that of 1915.

One reason is here apparent why such indifferent success is met with in predicting future runs on the basis of commercial packs of salmon. It is the number that escape to the spawning beds that have their influence on a subsequent generation, not the number sealed in cans, and the latter would often give a very erroneous basis for estimating the former.

It would seem, however, that where the escapement itself has been reliably ascertained for a number of years, a basis should be at hand for successful prophecy, with a fair degree of accuracy. The belief is generally held that increase in number of spawning fish up to the full capacity of the spawning beds will result in an increased run. The spawning beds of the Wood River chain of lakes to which there must have resorted in the old days 5,000,000 fish or more, can not be held fully populated by any number that have escaped the nets during recent years. A million fish at least should certainly find room to spawn in this great watershed without serious interference with one another's nests.

If they can do so, then the larger the number that spawn within these limits, or any more extensive areas of profitable spawning, the greater should be the resulting schools of fingerlings that pass out to sea in the spring and summer and the larger the returns in adult salmon when these come back to spawn.

If it should be assumed, however, that only half a million or a quarter of a million could profitably spawn, and that any larger number merely increased the wastage on the spawning beds and contributed nothing to the crop of fingerlings, on this basis and this basis only could a complete failure to establish a relation between increased spawning escapements and the larger size of the resulting runs be understood.

The Wood River experiment was inaugurated for the purpose of throwing light on this and on other problems, among them some of the most important that confront the commercial fisheries and fish propagation. If the experiment could establish the percentage of returns which could be expected under natural propagation from a given number of spawning fish; or, stated differently, the lowest percentage of escape that could be relied on to maintain the run intact, a sound basis would be laid for scientific handling of the fisheries. The results, both scientific and practical, would be far-reaching, and the conduct of the experiment all the more should be

above question. It was most unfortunate, for this reason, that Wood River was selected for the purpose. Its disadvantages were clearly seen and were discussed by Marsh and Cobb, in their report of the operations during 1908. The Wood River is not the only red-salmon stream tributary to Nushagak Bay. The main Nushagak, the Igushik, and the Snake also contribute their quota to the schools of fingerlings passing seaward through Nushagak Bay, and each of them receives its percentage of the escapement from the fisheries conducted in the open bay. It is not known what their respective percentages amount to. The streams have never been racked and the escapement tallied. It is currently believed that their runs, individually or even combined, are less important than the Wood River run, but the approximate number that must be added to the Wood River tally to produce the annual escapement from the entire fishing district is wholly a matter of conjecture. The salmon bound for these four streams enter Nushagak Bay together and are indistinguishable. Those captured by the commercial fisheries include members of all four colonies commingled, in their due proportions. What these proportions are no one knows. The chronicled escapement is for Wood River alone. It is evident that the total escapement from the commercial fishery and the proportion which this escape bears to the total run can only be obtained by assuming certain values for three unknown streams. Marsh and Cobb have done the best that can be done with a bad situation by assuming what they consider maximum and minimum values for the escapements to the unknown rivers. Interesting results are obtained in a field in which previously there has been no information, but the elements of uncertainty which reside in all conclusions based on the incomplete data of this experiment unfit them for either practical or strictly scientific purposes. Had it been practicable to rack each of the rivers and to obtain a census of the escapement into each, there would now be something certain on which to build. But the enterprise would be unnecessarily arduous. The desired results could be more easily achieved by abandoning the Wood River experiment and choosing for the purpose some river like the Chignik or the Karluk, where all the spawning fish of a given fishing district enter a lake or lakes through a single channel. But the Wood River census has not given us with any certainty the number of spawning fish which are necessary to maintain the Nushagak run, nor is the number known even approximately.

Marsh and Cobb have stated that although the census figures may not have absolute value, they can safely be used for purposes of comparison between one year and another. If this were true, we could still use them for purposes of prediction, as discussed in a preceding paragraph. If the total escapement from the Nushagak fishing grounds was always, year after year, the Wood River escape multiplied by a constant factor, the Wood River figures would be just as valuable for purposes of prediction as though we knew what the factor in question was. If the Wood River escape in a given year were half that of the previous year, we could then be assured that the entire escape for the district was half that of the previous year. But unfortunately, even for this purpose, the figures are unreliable. No constant factor can be assumed. Such assumption would register belief that the runs to the four rivers would in different years always vary in the same direction and to the same amount.

The mere statement of the case disproves it. Even the tributaries of one river vary widely year by year in the proportion of the total run which enters each of them. If this be true of the tributaries of a single river, how much more probable of four separate rivers, which join only at their mouths. It is certain that they would vary independently and that the oscillation might be of large dimensions. Due to manner of fishing, one of these rivers might experience a progressive reduction of its run that was not felt by the others. Prior to 1908, the Wood River fish ran the same gantlet in the outer bay as did those bound for the other rivers, and in addition were subjected to further reduction by traps and gill nets operating the entire length of Wood River. The main Nushagak and the Snake Rivers, at least, were wholly free from this further drain; their proportion of escape was demonstrably higher, and their runs should have fared better. In this complicated case, then, not only the natural oscillations in the runs to the different rivers, which might be at any given time in opposite directions, but also the possibility of progressive changes in the run of any of them, due to its different history must be contended with. If the Wood River run should for a term of years diminish relatively to the others, its escapement would diminish relatively to the escapement to the other three streams.

For these reasons, there has not been an attempt to establish a relation between the size of the Wood River escapements and the size of the resulting runs of salmon to the Nushagak with any high degree of expectation. There are too many unknown factors entering into the equation. Only on the assumption that the Wood River run so far overshadows the sum of all the others that the latter may be considered negligible, is the expectation warranted that close positive results can be achieved.

It is noted at the outset that the recorded escapement from 1908 to 1912 showed an alarming progressive decrease both in actual numbers of fish and in percentage of escape, but the five-year period that follows gives scant evidence of correspondingly decreased runs. It is also noted that the largest escapement by far—that of 1908—was responsible for the four-year fish of 1912, and the latter was one of the very poorest runs within the 10-year period under investigation. The 1908 spawning escape was recorded as 1,600,000 fish. The year 1912 had the very low record of 325,000 to reach the spawning beds, yet it produced the five-year contingent of the run of 1917, which furnished the largest run of any year since 1908. These are glaring failures, and indicate clearly enough that no such close relation exists between spawning escape on Wood River and the Nushagak run as will warrant predictions regarding the latter.

But if search is made for correspondences, which have a high degree of probability in their favor, such can be found. The years 1911 and 1912 were jointly responsible for 1916, when the total recorded run was the next to the smallest during the period of 10 years. The escapes both in 1911 and in 1912 were far below the average; in fact, with one exception they were the two poorest recorded escapes in the 10-year period. Whatever may be thought of the higher escapes, it looks as though the 325,000 of 1912 and the 354,000 of 1911 were sufficiently below an acceptable minimum to make a decided impression on the total run to Nushagak Bay. The possibility of a chance coincidence can not be eliminated here, and there is no similar case with which to check up. No other instance is recorded in the series

in which two exceptionally undersized escapements were in sequence, so that one would produce the four-year fish and the other the five-year fish of a later run.

The smallest escapement of the series was in 1915, when only 259,000 fish passed the Wood River weir. These furnished the four-year fish for 1919, the worst of all years on the Nushagak. Unfortunately, there is no record of 1914, the source of the five-year fish for 1919, so it can not be told whether two very small escapements again cooperated.

One other instance is worthy of attention. There is no record of the escapement in 1907, which was the year before the series began, but as the commercial returns of that year were the smallest from 1900, when fishing began on a large scale, to 1919, it is fair to assume that the escape in that year was very small. But 1907 produced the four-year fish for 1911, which was the next smallest year on record, and the five-year fish for 1912, which was the third smallest year. In this connection, the year 1920 on the Nushagak will possess unusual interest as showing how many five-year fish will have been produced by the smallest escapement of the series, that of 1915.

While admitting the possibility in all these cases of the chance association of numbers and giving due weight to that possibility the entire series is impressive as indicating on the whole a causal connection between size of spawning escape and size of resulting run; but the relation seems sometimes modified and sometimes effectually masked by the intervention of the other factors discussed on previous pages.

RECOMMENDATIONS FOR BRISTOL BAY.

Reasons have been assigned for the belief that the red-salmon pack in Bristol Bay has reached, where it has not passed, its maximum. It is believed that it is in danger of decline with the present scale of operations continued unchanged, and it seems probable that the present scale will be augmented. It is contended that some of the usual precautions should be taken to provide a larger spawning escape in this district. In no other salmon fisheries, except in certain portions of Alaska, are all effective restrictions removed, and unlimited fishing permitted, without seasonal or weekly close seasons, or protected areas. It is recommended:

1. That the Bureau of Fisheries seek to have the present law amended in such way that no Alaska districts will be relieved from the requirement of a weekly close season of 36 hours, during which no fishing is permitted. Bristol Bay is now one of several specifically exempted regions. No valid reason aside from the desires of the salmon packers can be assigned in any of these cases. All are in need of the protection that would be afforded by this regulation.

2. That all the Bristol Bay rivers be closed to commercial fishing at all points above their mouths, and that the mouths of these streams be determined by the Secretary of Commerce in his discretion, and that suitable marks be erected.

3. That a further attempt be made to enforce the provision that fish should be canned or otherwise preserved within 48 hours after their capture. One of the worst and most wasteful features of the Bristol Bay fisheries is the custom, during heavy runs, of permitting the daily capture of fish far in excess of the capacity of the cannery, with resulting daily accumulation of stale fish. This is done in anticipation of a slackening of the run, which will permit the cannery to catch up with its hoard of fish. But the run sometimes continues

for an unexpected period, and the weather may turn exceptionally warm. Then the stalest fish of the accumulated lot must be canned each day, or one or more days' catch must be thrown away. The regulation should be so enforced that not more than one day's surplus shall be on hand at any time. This would remove all dangers from the Bristol Bay pack and would at the same time be a powerful aid to conservation of the fisheries.

PORT MOLLER AND HERENDEEN BAY.

These localities could not be visited during the past summer, but one of the authors investigated the source of the runs of red salmon to this region in 1918, and found that contrary to the opinions of some packers the Bear River and the Sandy River produced, during that year at least, all the red salmon there captured. The Bristol Bay run in 1918 was very large, but no part of it skirted close in shore as far to the southward as Port Moller. Whether it ever has done so must now be judged by indirect evidence. For three years in succession, including 1919, yields of red salmon from this district have been very poor. Still, the amount of the decline is not as great as appears from the pack report of the only company which has operated for a term of years in the Bear River region. The Pacific American Fisheries captured about 1,125,000 red salmon off Port Moller in each of the years 1915 and 1916. In 1917 their capture was reduced to about a quarter of a million, and in 1918 it had recovered to half a million. But 1917 is the year in which the three canneries of Herendeen Bay began to compete for the Bear River and Sandy River salmon, which prior to that date had been solely at the disposal of the Pacific American Fisheries. If prior to 1917 the latter company were in fact, as seems probable, capturing a very large percentage of the available fish and if the total escape were very small the advent of the new companies could do little more than subdivide the year's product among the four participants. Making comparison on this basis, it is seen that whereas the catch in 1915 and 1916, by the Pacific American Fisheries was about 1,125,000 fish, in 1917 the combined captures of the four canneries were nearly 800,000 red salmon and in 1918 over 950,000 red salmon.

While the reduction in these years is notable and, in connection with the reduced pack which has followed in 1919, gives ground for grave apprehensions concerning the future yields of Bear and Sandy Rivers, it was not unexampled. Fully as great has been the falling off in many other overfished rivers. From this point of view, there is no necessity for assuming in explanation of the occurrences the former participation of any portion of the Bristol Bay run.

From another point of view, such participation becomes improbable. It is alleged to have occurred in 1915 and 1916, two years in succession, and then in subsequent years to have failed to make itself felt at the mouths of these rivers. According to this theory, the stream of Bristol Bay fish moved farther from shore and became inaccessible to this part of the coast on the very year in which new canneries began operations there, and this diversion of the run has continued each year since that time, irrespective of the size of the Bristol Bay run, which was larger in 1917 and in 1918 than in the two preceding years.

Taking all the known facts into consideration, it is believed that the red-salmon captures in the Bear River region have been local fish bound for Bear and for Sandy Rivers and that the reductions

which have undoubtedly occurred in these runs have been the result of previous overfishing.

A partial suspension of the fishing operations in this region is recommended to permit a recovery of the run, but there seems to be no way of enforcing more stringent restrictions under the present law. No fishing is conducted in Bear or in Sandy Rivers, nor within the prescribed distance outside the mouths of these streams. But owing to the favorable configuration of the beaches and offshore slopes, and the considerable stretches of coast off which these fish school up before entering fresh water, the purse seines are very effective. These, with the two traps located at the legal distance either side of the mouth of Bear River, come perilously near effectually blocking the passageway to the river.

This is another instance of the hopeless insufficiency of the present law, which places beyond the jurisdiction of the Secretary of Commerce the salt-water approaches to the mouths of the rivers, however seriously the form of fishing there may menace the salmon supply.

IKATAN AND MORZHOVOI BAYS.

A brief visit to this district produced certain observations in continuation of those made by one of the authors the preceding season.

No red-salmon stream exists in Ikatan Bay, or in the immediate vicinity, toward which the red salmon captured in that region are headed. The heavy schools which pass near the Ikatan beaches are bound elsewhere and dip into the bay for unknown reasons. Similar movements of migrating salmon are known elsewhere, as for example, considerable numbers of Karluk fish which school off the southern shore of Uyak Bay. At Ikatan their movements may conceivably have some relation to the opening of False Pass into the upper end of Ikatan Bay. False Pass is the only channel east of Unimak Pass, which connects the Pacific with Bering Sea. Tidal currents rush through this pass with great velocity, and a certain admixture of the waters of the two seas undoubtedly occurs. Whether any physical feature is here presented which forms a passing attraction to the migrating fish, can not be stated.

Although the Ikatan fish are bound elsewhere, they are not bound for Bristol Bay, nor is it believed they traverse False Pass in any numbers. They belong to the southern side of the peninsula and find their spawning grounds principally in Morzhovoi Bay and at Thin Point. So, although not spawning in Ikatan waters, they are local communities of fish destined for small streams which are at no great distance. In all cases of this kind, care must be exercised not to overfish the district and exhaust the runs. The danger of doing this is always magnified when local conditions render the schools of salmon particularly susceptible to attack. In many districts, the spawning runs first become evident when they school immediately off the mouth of the river. If fishing conditions are there unfavorable the percentage of escape will probably be large. But the Morzhovoi and Thin Point fish, which school up off Ikatan, pass before long beaches in which traps can be driven, and in waters where the purse seines are effective. They sustain a double attack, either of which is of great magnitude. Here again, it seems impossible adequately to protect an important school of fish, because no authority to restrict fishing along the salt-water channels has been conferred on the Secretary of Commerce. Yet it is believed possible wholly to

destroy this run for commercial uses by continuing the policy of unrestricted competition which now exists. A third cannery has recently been constructed to draw on this run and is planning an increase in its operations. And three other canneries, situated unfortunately where adequate supplies were locally not available, have sent fleets of purse-seine boats to Ikatan. It is believed the district can not sustain fishing on such a scale, but it is not possible, under the existing law, to devise a remedy.

KARLUK RIVER AND LAKE.

An examination of Karluk Lake and River was made July 25 and 26, the observers walking across the trail from the head of Larsen Bay to a point on the Karluk River, proceeding thence by boat and on foot to the lake. After inspection of all the spawning beds along the lower half of the main lake, the river was descended to its mouth, by boat. It was regretted that time did not permit an examination of the upper half of the main lake and of the smaller lake and its tributaries.

On the way up river from the portage to the lake but few salmon were seen, but at the narrowed lower end of the lake, immediately above the outlet, a large school of salmon was found, consisting of fish that were not yet completely ripe and ready for spawning. These fish were lying relatively still, unless disturbed, when they would rush off in a body, with a great roar of breaking water. It was estimated that there were between 2,000 and 3,000 fish in this school.

Passing along the western shore of the lake, scattered salmon were found, and schools of no great size were about the mouths of all the small creeks that dash down the abrupt slopes on that side of the lake. Salmon were trying to ascend all these small streams, making frantic efforts to pass up through the broken water which forms a series of waterfalls and rapids among great rocks and coarse bowlders. These streams seemed wholly unfitted for spawning. They were short, violently rapid wherever seen, and appeared to be without quiet gravelly reaches where spawning could be successfully accomplished. The shallower portions of the lake, in depths where fish frequently spawn, were on the west side also for the most part totally unsuited for spawning. The bottom was thickly covered with coarse cobblestones and bowlders, without finer materials in which nests could be excavated. Here and there were gravelly or sandy beaches of small extent, but none of those on the west side of the lake gave evidence of being extensively used by the salmon.

Crossing to the eastern shore, there were found larger and longer streams, rapid brawling creeks, with coarse bowldery beds, but far more practicable than the creeks of the west side. As the mouths of the streams were approached, dead salmon that had drifted out after spawning lay thick on the bottom of the lake, and upon wading up the rough beds of the creeks, dead salmon were found lying everywhere, lodged among the bowlders or stranded on the shallows. Spawning, however, was vigorously in progress. The creeks were fairly beset with living fish seeking to spawn among their dead comrades, while off the mouths were small schools, from which a constant series of recruits passed up the rocky incline to take the place of those exhausted and dying. No gravel bars or quiet reaches were seen, and while these streams were the least unfavorable of those observed entering the lower half of the lake, it seemed incredible that any large

number of salmon could successfully conceal their eggs in the narrow sand intervals between the rocks. As a matter of fact, loose eggs were seen passing down the current to the lake.

The eastern shore of the lake in its lower portion has long stretches of sandy and gravelly beaches, which seem well suited to serve as spawning beds, so far as the nature of the sediment was concerned. But the salmon did not congregate along this shore except at the entrance of larger or smaller creeks, and there was no evidence that these beach gravels were availed of to any considerable extent.

One of the lowest streams to enter on the eastern or right shore of the lake had a very different character from the others. It was a short stream, apparently not more than a mile in total length, and was spring-fed. Near the upper end it expanded to cover a basin which contained several acres, and at that time was 2 or 3 feet deep. Below this so-called lake, the channel was gently inclined, with a series of pools connected by gently-flowing stretches. Near the mouth the slope became steeper, but the stream was never turbulent.

This creek has certain characteristics that on cursory examination seem to fit it for hatchery purposes. Natives affirmed that it does not freeze in winter, being unlike all the other creeks in this respect. It contained but few spawning salmon, however, fewer than any other stream examined, a circumstance that can not be accounted for, unless possibly the temperature of the spring-fed stream was lower than is found in the other tributaries of the lake.

The salmon seen near the outlet of the lake, those around the shores, and those living, dead, and dying in and about the streams, are estimated at 5,000 or 6,000. It is impossible to give any opinion as to the adequacy of the escape to the lake during the present season.

On the way down the river, especially in the very rapid portion below the point where the trail makes off to Larsen Bay, many fresh-run red salmon were seen working their way up against the current, or resting under the lee of the coarse bowlders, which almost everywhere form the bottom of this portion of the river. There were no eddies of consequence along the banks, and the salmon were distributed throughout the width of the river. It was impossible to form any estimate of the numbers present, but there must have been many hundreds of them in the river.

The writers were impressed with the unfavorable nature of the grounds examined, by their small extent, and by the unbroken succession of spawning fish which continue to occupy these small creeks during the long season. Enormous waste of eggs must accompany this condition, and as the test of the efficiency of any hatchery lies in its advantage over natural propagation, under the local conditions in which it operates, it is believed that a red-salmon hatchery on Karluk Lake would operate to the very material advantage of the salmon run.

It is recommended that a thorough survey be made of the lake and river during the fishing season of 1920 by a party of two, one member being a practical hatchery man and the other a scientist. A survey should be made of a transportation route from Larsen Bay to the lake, a hatchery site should be selected with full knowledge of the conditions throughout the year, and the distribution of the salmon should be studied throughout the lake spawning beds. As accurate a census as possible should be made of the spawning fish.

FISHERY INDUSTRIES OF THE UNITED STATES

REPORT OF THE DIVISION OF STATISTICS AND METHODS OF THE FISHERIES FOR 1919

By Lewis Radcliffe

Assistant in Charge

Appendix X to the Report of the U. S. Commissioner of Fisheries for 1919

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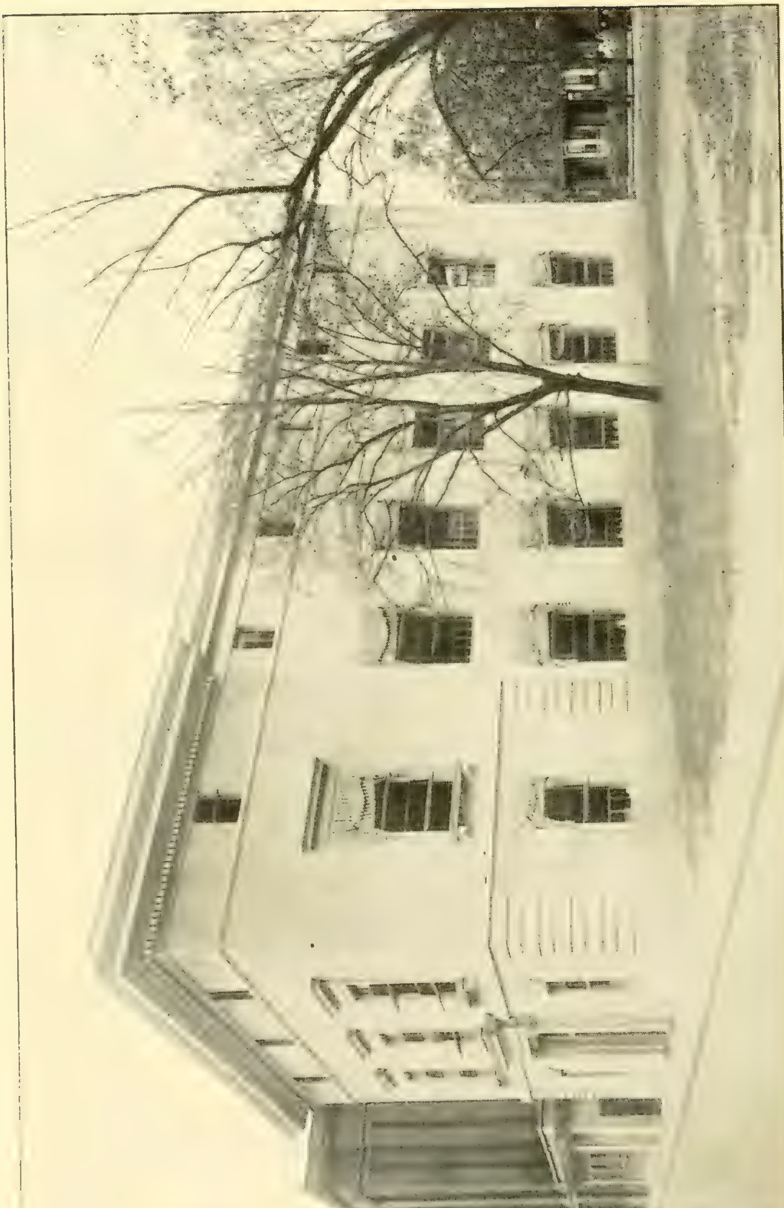


FISHERY PRODUCTS LABORATORY, WASHINGTON, D. C.

FISHERY INDUSTRIES OF THE UNITED STATES.

REPORT OF THE DIVISION OF STATISTICS AND METHODS OF THE FISHERIES FOR 1919.

By LEWIS RADCLIFFE, *Assistant in Charge.*

INTRODUCTION.

On the basis of canvasses of the fisheries made in the last decade, the present annual production of fishery products in the United States, including Alaska, is estimated to be about two and one-half billion pounds, valued at approximately 80 million dollars to the fishermen,[1] an industry employing more than 200,000 persons. For the fiscal year ended June 30, 1918, the value of the imports of fishery products was $26,268,014 and of exports, $57,017,427.

Among the important functions of the Division of Statistics and Methods of the Fisheries of the Bureau of Fisheries in its relations with the commercial fisheries are the following: (1) Studies of the methods of conducting fishing operations for the purpose of effecting improvements and revealing the use of unnecessarily destructive or unprofitable methods; (2) the development of improvements in the methods of handling, distribution, and marketing of fishery products; (3) technological investigations of the underlying scientific principles governing the preservation of fishery products in order to standardize methods and effect improvements and economy of operation, to determine feasibility of preserving fishery products by untried methods, and to discourage the use of unsatisfactory, wasteful, or uneconomical practices; (4) to introduce useful foreign methods or processes of capture, preservation, and utilization of fishery products; (5) to develop the use of the by-products of the fisheries and the unutilized products of the sea to the greatest economic advantage; (6) to increase the demand for the little used or neglected fishes and fishery products for food; (7) to collect the statistics of the fisheries and fishery industries; (8) to study the vessels and boats employed, for the purpose of effecting improvements; (9) to study and develop fishing grounds and fisheries for hitherto unutilized fishes; and (10) to disseminate information bearing on the commercial fisheries. For the conduct of its work in these fields during the fiscal year beginning July 1, 1919, Congress appropriated $15,000.

SUMMARY OF OPERATIONS.

During the year the Bureau has aided in the development of fisheries for black drum, sharks, and porpoises and in increasing the

[1] The value of Alaska's fishery products in 1918 as prepared for market was $59,154,859, but the estimated value of the fish to the fishermen was only about $11,000,000, which is the amount included in the estimate given above.

use of black drum, grouper, mussels, red drum, whale meat, and other neglected fishery products for food. By means of practical demonstrations and lectures, many persons have been more fully acquainted with the dietetic qualities of fish, have been encouraged to use this wholesome food in larger quantities, and have been shown that certain of their prejudices against its use were without foundation.

Efforts to increase the use of the by-products of the fisheries to the most economical advantage have been continued. The more extended use of fish and shrimp waste, its manufacture into fish meal as an animal feed, the use of the hides of sharks, porpoises, and other unutilized aquatic animals for leather, the drying of shark fins for the oriental trade, and the like have been encouraged. Analyses have been made of the liver oils of several species of sharks, of tuna oil, etc., to determine more definitely their individual properties and the uses to which they appear best suited.

The construction of the Fishery Products Laboratory in Washington, begun in December, 1918, was completed the following June, and the equipment of it is practically complete. Various important investigations have been inaugurated, such as a technological study of the methods of salting fish, experiments in the recovery of old salt and brine for reuse, a preliminary examination of some of the features of foreign methods of freezing fish in brine, development of possible methods for the production of essence d'Orient from the scales of native fishes, and some preliminary tests of the practicability of putting noncommercial sponges to commercial uses. At its experimental laboratory at San Pedro, Calif., methods of canning the Pacific coast mackerel have been developed, considerable attention has been given to canning other local fish, such as barracuda, bonito, and rockfishes, and the fishing industry of that coast has been given all possible assistance.

Detailed statistics of the vessel fisheries centering at Boston and Gloucester, Mass., Portland, Me., and Seattle, Wash., have been collected and the results published in the form of monthly and annual bulletins for trade use. A statistical canvass of the coastal fisheries of the South Atlantic and Gulf States for the calendar year 1918 was begun early in 1919 and nearly completed by the end of the year. In addition, canvasses of the shad fishery of the Hudson River for 1919 and of the shad and river herring fishery of the Potomac River, also for 1919, have been made. With the exception of the coastal fisheries of the South Atlantic States, the present report contains the results of these canvasses, together with the detailed tables of the canvass of the fisheries of the Great Lakes for the calendar year 1917 and the fishery products received at the Municipal Fish Wharf and Market, Washington, D. C., for 1919. Statistics of Alaska fisheries are collected annually and published in the Bureau's annual report on Alaska Fisheries and Fur Industries.

The inadequacy of the present personnel for this division's part of the Bureau's work has called for the maximum of service from its members to complete the program outlined above. This has been given loyally at a time when higher compensation and much more adequate returns for their labor could have been obtained elsewhere.

AID IN DEVELOPMENT OF FISHERY FOR BLACK DRUM.

The black drum (*Pogonias cromis*) is a predacious fish, very destructive of oysters, particularly on cultivated beds, where the oysters occur singly and may the more readily be seized and crushed. This species is quite common on the South Atlantic and Gulf coasts, migrating northward along the coasts of the Middle Atlantic States in summer. It not uncommonly reaches a weight of 60 pounds or more. Complete data as to the movements of the fish and the possibility of establishing a regular fishery have been lacking, and the demand for the fresh fish has been insufficient to care for the catch. In fact, the fishermen frequently avoid taking it in their nets. An examination of samples of canned black drum indicates that it is excellent for this purpose, resembling the meat of poultry.

Wishing to provide persons interested in the development of the fishery with more detailed information as to localities in which the fish might be taken in commercial quantities and as to seasons of abundance, an assistant was detailed to visit the principal fishing centers on the Gulf coast. On the Florida coast south of Tampa the black drum is reported to be plentiful for about four months of the year, beginning with April, and at Cedar Keys, throughout the year, being taken principally in Withlacoochee Bay, on Port English, and Waccassassee and Suwanee Bars. Cedar Keys would, therefore, appear to be the most promising point on the Florida coast for a fishery. To the westward conditions are less favorable, the fish being very scarce at Pensacola. At Mobile, Ala., the fish is said to be plentiful throughout the year, but up to the present season there had been no demand for it. At Biloxi and Gulfport, Miss., it is scarce; in Louisiana waters some are taken throughout the year, but no large schools are observed. At Galveston, Tex., a few are taken in all months. Corpus Christi supports a fishery, but the demand has lately fallen off as a result of publicity wrongly intimating that the fish were unfit for food. At Point Isabel about 70 per cent of all fish taken are reported to be drum. These are taken throughout the year with pocket nets; that is, drag seines provided with pockets. The seines are 300 to 500 feet long of No. 24 cotton twine, $1\frac{3}{4}$-inch bar mesh. Point Isabel appears, therefore, to be the most promising place on the Gulf for a fishery. Fish from this point and from Mexico are re-iced and shipped to market from Brownsville, Tex., the fishermen receiving about 2 cents per pound for the catch.

INCREASING THE USE OF FISH AS FOOD.

DEMONSTRATIONS IN FISH COOKERY.

In previous reports attention has been called to the practical demonstrations and lectures in fish cookery initiated by the Bureau in May, 1918. These were intended to extend the use of cheaper, more abundant species in each locality, to introduce appetizing, inexpensive methods of cooking fish while conserving labor and eliminating the use of expensive cooking fats and oils, and to encourage the use for food of parts of the fish usually discarded. At the beginning of 1919, the holdings of fish in the cold storages of the country were about double normal, with the result of imminent danger that large quantities of these fish saved during the war period would have

to be destroyed for lack of markets. On this account demonstrations on the west coast were brought to a close in January, 1919, and the demonstrators detailed to the middle west, giving a series of demonstrations in St. Louis, Chicago, Minneapolis, St. Paul, Cincinnati, and Cleveland. At these meetings special attention was directed to the value of frozen fish for food, particularly to the little-known varieties with whose merits the average housewife was unacquainted.

A successful series of demonstrations was later given in Boston and Cambridge, Mass. To enable local agents of the States Relations Service of the Department of Agriculture to profit from training in this field and extend its benefits to their respective communities, one of the Bureau's assistants gave demonstrations in Key West, Miami, West Palm Beach, Titusville, and St. Augustine, Fla.; in Savannah, and Valdosta, Ga.; at the Agricultural and Mechanical College of Mississippi; and before a gathering of State agents in Washington, D. C.

It is the consensus of opinion, as attested to verbally and by letter by those attending the demonstrations, that the housewives are very grateful to their Government for its interest in their problems of providing wholesome protein food at low cost. The value to the trade, as evidenced by reports of increased demand for fish in places in which demonstrations have been given, is well vouched for. During the year in which this work was conducted more than 125 demonstrations were held, by means of which approximately 15,000 persons were reached directly and many more indirectly.

In reviewing the work, consideration should be given to the fact that protein is the high-priced element of food; that fish compares favorably in protein content and digestibility with meats; that our estimated annual per capita consumption of meat is more than 160 pounds, while that of fish is only about 18 pounds; and that our fisheries annually yield millions of pounds of food fishes which are not so marketed, due in large part to lack of demand by the consuming public. Although the value of these demonstrations has been attested by the consumers, home demonstration agents, the trade, and others, and although the Bureau has been urgently requested to continue this work, it was compelled to abandon it in June for lack of funds.

In addition to the practical demonstrations in the field, experiments have been made to determine the best methods of preparing various fishery products for the table. This has been confined largely to products with which the housewife was little acquainted. Such information has been supplied directly to the trade or used in the preparation of economic circulars. A cookbook on fishery products has been prepared, but will be broadened in scope before it is published.

GROUPERS.

The groupers occur in abundance on the east coast of Florida and on the snapper banks in the Gulf of Mexico, where they outnumber the more highly prized red snappers. Until quite recently the snapper fishermen were required to limit their catch of grouper to from 10 to 25 per cent of the fare because of lack of demand. Gradually this percentage was increased until during the war period, when the number of vessels operating and men engaged were considerably reduced,

the demand equaled or exceeded the catch. With the return of men and vessels to the fishery, production again exceeded demand.

With the object of preventing needless waste of these fish and increasing efficiency of operations with reduction in cost of product to the consumer, the Bureau undertook to develop larger markets which would absorb the entire catch. For this purpose it issued an illustrated placard recommending these firm, white-meated fish and an economic circular containing recipes for preparing them for the table, and detailed an assistant to aid in encouraging the use of these fish in cities in the South. In this campaign particular attention was given to encouraging dealers to handle the groupers, to instructing them in the best methods of preparing the fish for sale, and to increasing their use by restaurants and cafés. Groupers are usually shipped headed and gutted. For sale to the consumer it appears desirable to skin the fish and remove the fins. They are then suitable for filleting. These operations, as described in Economic Circular No. 44, follow:

> Lay the fish on its side, with the head end pointing toward you and the back toward the knife hand (the hand with which the operator uses the knife). Insert the knife to a depth of 1 to 1½ inches behind the end of the back fin and draw the length of the fish, cutting close to the fin, thus severing the skin and the flesh from tail to head.
>
> Turn the fish end for end, laying it on its other side, and repeat as above, drawing the knife along the length of the fin from the head to the tail. Using a piece of burlap to prevent the hand slipping, or a pair of pliers, catch the back fin at the front end and pull it out.
>
> Turn the fish, tail pointing from you and the belly toward the knife hand. Grasp the pectoral fin, the fin just back of the gills, in the free hand and thrust the knife into the fish just back of it and cut both ways. The collar bone, which is thus cut loose, is removed by pulling on the fin. The small, thin bone remaining, which connects the hide and meat, is removed with a stroke of the knife. Repeat the operation on the other side.
>
> Turn the fish, tail pointing toward you and the belly toward the knife hand. Complete the splitting of the fish, and remove the belly fins. With pliers or a piece of burlap catch the corner of the hide at the head end nearest the back and strip off by pulling toward the tail. Repeat the process for the other side and complete the removal of the skin and tail by a stroke of the cleaver at the base of the tail fin.

It appears that the results which the Bureau expected to accomplish have in a measure been negatived by other factors, such as labor difficulties.

INCREASING THE USE OF BY-PRODUCTS OF THE FISHERIES.

The development of uses for the by-products of the fisheries and the unutilized products of the sea to the greatest economic advantage represents one of the most promising fields for research and for increasing the Nation's resources open to the Bureau. Although handicapped through lack of provision for the permanent employment of an adequately trained technologist and for funds, it has continued its efforts in this field in so far as its limited facilities will permit and has achieved results cited in the following pages which indicate the importance of the work and the possibilities of saving fishery products possessing a value many times the cost of the service. Among its activities mention should be made of the results of its efforts to increase the use of fish waste and waste fish for conversion into oil and scrap for fertilizer, to encourage the production of fish and shrimp meal as an animal feed, the use of the hides of fishes and other unutilized aquatic animals for leather, the development of a fishery for sharks, and the reestablishment of fisheries for porpoises, sea lions, hair seals, and other unutilized aquatic animals.

FISH OILS.

The demands and uses for fish oils are increasing and the prices are unusually high. Among the various uses are the following: Drying oil in paints and varnishes, stuffing grease for leather, in soap-making, lubricating compounds, tempering steel, screw-cutting, and cordage manufacture, for medicinal and illuminating purposes, in the manufacture of rubber substitutes, top dressings for automobile tops, awnings, tents, and the like, in lard substitutes, etc., after hydrogenation.

In recent years the annual production of fish oils has ranged from about 5 to 6 million gallons. Of this, more than half is menhaden oil, whale, sperm, and herring oil being produced in appreciable quantities with smaller amounts of other oils, such as cod liver, shark liver (including dogfish), salmon, tuna, sardine, porpoise blubber and jaw oils, seal, and walrus. Imports entered for consumption for the fiscal year ended June 30, 1918, amounted to 4,881,982 gallons, valued at $3,638,749, and exports in that year were 455,629 gallons, valued at $446,589.

Realizing the importance of determining more definitely the special properties of those oils for which such information was lacking, to indicate the uses to which they are best suited, the Bureau has made analyses of the body and liver oils of species of sharks, of skate-liver oil, tuna and yellowtail oil, and has furnished the educational bureau of the Paint Manufacturers' Association of the United States various samples of fish oils for analysis and trial as to suitability for use in the manufacture of paints and varnishes.

Albacore or tuna (*Germo alalunga*) oil is particularly interesting because of its excellent drying qualities. It possesses very little unsaponifiable matter and little odor and is pale in color. Drying tests made by the director of the educational bureau of the Paint Manufacturers' Association of the United States showed that it dries even more rapidly than linseed oil. The 1919 production of albacore (*Germo alalunga*), yellowfin tuna (*G. macropterus*), and bluefin tuna (*Thunnus thynnus*) oil in southern California is estimated to exceed 100,000 gallons. An analysis of the albacore oil gave the following results: Specific gravity at 15.5° C., 0.9298; acid value, 0.24; saponification value, 195.9; iodine value (Hanus), 184; refractive index (40° C.), 1.4755; titer test of fatty acids in degrees centigrade, 20.8°; neutralization value of fatty acids, 182.5; mean molecular weight of fatty acids, 307; total unsaponifiable matter 0.80 per cent. Tests with the oil of the yellowtail (*Seriola dorsalis*) indicated that it was fully as satisfactory for the manufacture of paints as menhaden oil, but not as good as the albacore oil. Its color was light and its odor not strong.

There is need for more exhaustive investigations of fish oils, for determining definitely the qualities of the oils of various species of sharks, skates, and other fishes serving as sources of supply of fish oils; for determining more definitely the possibilities of hydrogenating fish oils for use for edible purposes, their nutritive values based on investigations by experts in vitamines, etc. On the subject of hydrogenation, Bulletin No. 769 of the United States Department of Agriculture, February 10, 1919, page 39, states:

> Recently a refining process in which hydrogen instead of steam is used to blow the oil has been developed. It appears that it is now possible to remove the disagreeable

odor and flavor from some kinds of fish oils and render them suitable for food. For several years whale and possibly some fish oils have been hardened by hydrogenation in Norway and Germany, and within the last six months a lard substitute made in this way from Pacific coast herring has appeared on the American market.

Before the war whale oil was being hydrogenated in Norway, the Netherlands, and Germany, and a plant is now in operation in England capable of caring for all whale oil likely to arrive. The hardened fat is white, odorless, and tasteless. It is used as a substitute for tallow and the best quality for margarine.

FISH SCRAP.

The annual production of scrap for fertilizer will approximate 60,000 tons. In 1918, on the basis of available data, the production of menhaden scrap amounted to nearly 50,000 tons, that of sardine, salmon, tuna, etc., on the west coast, including Alaska, to more than 2,300 tons (exclusive of fish meal), and that of the Alaska whale fishery to 850 tons. Additional material is produced in New England, especially in connection with the fishery for sardines and herring; in the States bordering on the Gulf of Mexico, principally from shrimp waste; on the Great Lakes, etc. The use of sardines for conversion into oil and scrap or meal on the coast of southern California appears to be on the increase, over 33 million pounds having been reported so used in 1919. It is reported that a ton of sardines will yield up to 25 gallons of oil and 500 pounds of meal or scrap.

Persons in the fisheries have been encouraged to save their fish waste and have been furnished information regarding methods and machinery. To care for the comparatively small quantities of waste, there appears to be need for an efficient and inexpensive plant—one that is capable of reducing the oil content of the scrap to a low percentage.

FISH MEAL.

To meet the increasing demand for protein feeds for hogs, cattle, and poultry, the Bureau has continued to urge upon the manufacturers employing fish waste the importance of using such of their products as are suitable for manufacture into fish meal. As the menhaden industry affords the greatest prospective source of supply, particular attention has been given to this field. The shrimp fishery of the south Atlantic and Gulf States is another promising field, in which until recently not more than 50 per cent of the waste has been used. One of the Bureau's assistants who visited this field during the year estimates that this industry is capable of yielding from 7,500 to 10,000 tons of raw waste, equivalent to from 1,500 to 2,000 tons of scrap or meal per annum. At the time of his visit, this waste was not being utilized in the Apalachicola and Fernandina (Fla.) districts, nor in the St. Marys and Brunswick (Ga.) section, districts which should supply about three-eighths of available material. The bulk of that now saved is in the Barataria Bay district, the center of the shrimp-drying industry, in which the shrimp are sun-dried on large wooden platforms. The heads and shells are a by-product. It is believed that the successful solution of the problem will require the use of rotary driers, and at least three companies made provision during the year for the saving of this material.

Samples of shrimp meal analyzed contain from 43 to 56 per cent protein. Following is an analysis of one sample:

	Per cent.
Moisture	5.03
Ash	29.89
Fat (ether extract)	3.62
Protein	47.44
Undetermined	15.02

The Bureau of Animal Industry of the United States Department of Agriculture has cooperated very effectively with the Bureau in this field in the conduct of feeding experiments with fish and shrimp meals to hogs and in directing the attention of hog growers to the value of these products as feeds, thus rendering material aid in assuring those in the fisheries of a market for their product. In an experiment of the Bureau of Animal Industry, conducted at the Government Experiment Station, Beltsville, Md., in which two lots of 15 pigs were fed fish meal and shrimp meal for a period of 91 days, the results indicated that shrimp meal was fully the equal of fish meal. It is believed that elements other than the proteins, such as the mineral elements, vitamines, etc., tend to enhance the value of this material.

Grayfish meal has been furnished the Bureau of Animal Industry for a feeding test, the results of which were comparable to those obtained by feeding with menhaden meal. Although the grayfish meal contained a high percentage of oil, no flavor of fish could be detected in the flesh of the hogs killed at the end of the feeding experiment. Arrangements are being made for additional feeding tests to ascertain more definitely the safety with which meals containing a high oil content or made from decomposed materials may be used.

The American consul at Odense reports that in Denmark a shellfish meal made from the blue mussels which are found in large numbers along the Danish coast is now on the market in that country as a poultry feed and has proved very satisfactory for increasing egg production. An analysis of the dried meal made at an agricultural experiment station quoted from Commerce Report No. 32, February 7, 1919, follows:

Lime (in the form of ashes), 71.41 per cent; sugar, starch, and other organic matter, 13.21 per cent; nitrogenous matter, 11.64 per cent; fats, 1.68 per cent; and water, 2.06 per cent.

Comparatively little fish meal was produced in this country prior to 1914. Beginning with that year the production on the west coast has steadily increased, the 1918 production of the coastal States and Alaska being about 8,684 tons. An assistant who visited the principal centers of production in southern California during the year reports no differences in character of material or process of manufacture of meal or scrap except in a few instances in which the ground scrap is called meal. Until more detailed information is available regarding the results of feeding fish meal it is believed that only fresh waste should be used in its manufacture and badly decomposed waste made into scrap for fertilizer. Some kinds of meal do not require grinding. This is stated to be the case for meal made from sardines in which the steam, or so-called batch, drier is used. If a hot-air drier is employed, grinding may be necessary to reduce the material

to the proper degree of fineness and to break up any small, sharp-pointed bones or spines. This was found necessary for menhaden meal. The most practical type of grinder for breaking up such bones appears to be the swing-hammer type, in which swinging hammers revolving at about from 2,500 to 3,000 revolutions per minute knock the material against a screen.

As evidence of the results of the Bureau's efforts, it may be added that in the menhaden and shrimp industries about 2,500 tons of meal were produced in 1919 and no difficulties in marketing it at reasonable prices reported. It is believed that the present annual production of meal from fishery products approximating 10,000 tons may be doubled without difficulty and with improvements which will keep menhaden fresh until they reach the factory at least trebled. It may be noted that a classification for fish meal is in effect in the three classification territories of the railway companies, and class rates on this commodity between given points are obtainable by application to the proper railroad officials.

FISH LEATHER.

The work of the Bureau in encouraging the development of a fish-leather industry has resulted in important progress in this field. The tanning of the hides of sharks and rays into leather which is soft and pliable and of ample strength for many uses is now an established fact, and keen interest is being shown in the development of fisheries for these forms to make available regular supplies of basic materials in quantity production. The use of the hides of porpoises, whales, sea lions, and other unutilized aquatic animals is also increasing. One tannery is now devoted to the production of fish leather, a second is in course of construction, and others are preparing to engage in the industry.

SHARK FINS.

The Bureau has been instrumental in the saving and drying of shark fins, which are a delicacy highly prized by orientals. In one city in this country the demand now exceeds the supply, the best grades commanding from 65 to 75 cents per pound.

The trade is furnished with descriptive matter for the preparation of the various by-products, oils, scrap, meal, hides for the tanner, and fins, and with information as to where the various commodities may be marketed.

TECHNOLOGICAL INVESTIGATIONS.

In the 1918 report attention was called to the construction and equipment of a Fishery Products Laboratory in Washington for the conduct of technological investigations in the fisheries. Although its activities have been greatly restricted by the limited personnel and provision for the work, the results achieved in the investigations regarding the salting of fish, the studies of fish oils, recovery of used brine and salt, preliminary studies of the production of essence d'Orient from fish scales, and the different methods of refrigeration, the direction of the investigations in the canning of fish in southern California, and provision for the proper handling of minor problems, have emphasized the need for the conduct of such work on a larger

scale. The sundry civil appropriation act of July 19, 1919, contains provision for an additional assistant for the Fishery Products Laboratory, but in the examination held before the end of the calendar year no applicant qualified.

DETERMINATION OF PRINCIPLES OF PRESERVATION OF FISH WITH SALT.

Recent reports have contained reference to the technological investigations on the preservation of fish with salt, initiated for the purpose of determining the basic principles governing this method of preservation, to effect improvements in present practices, and to develop satisfactory methods of salting fish at higher temperatures and therefore in warm climates. The preliminary investigation has been completed and the results published in Bureau of Fisheries Document No. 884, "Some Considerations Concerning the Salting of Fish," by D. K. Tressler. A brief summary of some of the results follows:

On the assumption that the more rapidly salt penetrates the flesh of fish the sooner will decomposition be stopped, the first work aimed to determine the rate of penetration of salts of different qualities into the flesh, the squeteague being used. Small amounts of calcium chloride or magnesium chloride retarded the rate of penetration of pure salt (sodium chloride), but produced a firmer, whiter fish than the pure sodium chloride. Other impurities, such as the sulphates, had a similar though less noticeable effect. In this connection it may be of interest to note that analyses of commercial salts reveal the fact that they vary greatly in purity. Solar salts are of lesser purity than salts prepared by evaporation in open or vacuum pans, and most domestic salts are of greater purity than foreign salts available in large quantities. The purest brands obtainable at reasonable cost contain between 99.5 and 99.75 per cent of sodium chloride.

As the rate of penetration in itself was an insufficient index of the keeping qualities, it was considered essential to provide some means of measuring the amount and rate of decomposition of protein in order to determine the amount of decomposition taking place in the course of salting any lot of fish, and thus test the value of the various methods. Having salted fish with prepared salts containing different amounts of the common impurities (calcium, magnesium, and sulphates), the rate of protein decomposition was estimated by determining the amounts of amino-acid nitrogen formed. In this manner the preservative action of the various salts on the protein of the fish was estimated. Calcium and magnesium salts and sulphates cause an increase in decomposition and therefore produce a less perfect preservation of the fish during salting. This reveals the importance of selecting brands of salt low in these impurities for salting fish in warm climates. For salting at temperatures below 50° F. it is possible to exercise a measure of control in producing fish of the desired quality by the use of salts having a high percentage of calcium and magnesium if a hard, white fish is desired and pure salts if a soft, pliable fish is wanted. The degree of fineness of the salt is considered of little importance save in a physical way.

A comparison was made as to the relative efficiency of the two general methods of salting fish, viz, by the use of dry salt or brine and salt, by determining the rate of penetration of salt into the flesh of fish salted by each method and the rate of protein decomposition. These experiments showed that the salt penetrates more rapidly in the dry-salted fish than in the fish in pickle and that more amino acid was formed by the brine method. The dry-salt method is apparently the more economical of both salt and labor.

In addition, experiments were made to determine the effects of a more thorough cleaning of the fish before salting, the rate of formation of amino-acid nitrogen being used to indicate the rate of protein decomposition. River herring cleaned by various methods were salted at high temperatures. All except those from which all roe or milt and blood had been removed spoiled, the thoroughly cleaned fish being successfully salted at 88° F. From these experiments it was concluded that the chief cause of spoilage during salting is due to the decomposition of the blood remaining in the flesh.

The rate of penetration of salt into skinned fish was found to be about double that in the unskinned fish, thus revealing the importance of splitting fish before salting.

Experiments made in salting fish of various degrees of staleness showed that the length of time a fish may be kept before salting depends upon the temperature to which the fish are subjected before and during the salting period, and that at some temperature between 50 and 60° F., or higher, fish spoil very quickly.

The following are important considerations in the salting of fish in warm climates: All viscera and blood should be removed in cleaning, large fish should be split, the fish salted should be in a fresh condition, no brine should be added, and salts low in calcium should be selected.

At the close of the year plans were being perfected for the practical application on a somewhat larger scale of the results obtained in these small-scale laboratory experiments to determine more definitely the manner in which these results may be applied with profit to the industry. These plans include the salting of river herring at points in Florida where usual practices have previously proved a failure. In addition to the work outlined above, some attention has been given to the chemical changes in the fat content of fish.

FREEZING FISH IN BRINE.

Refrigeration as a means of preserving fish promises to play an increasingly more important rôle in the fishing industry. In this connection there exists a feeling that more of our energies hitherto expended in perfecting refrigeration machinery and methods should be applied to effecting improvements in the quality of the product and in educating the consumer to its merits, its care, and preparation. In Europe the process of freezing fish in brine has of late been receiving considerable attention, and the use of the method is increasing. Brief mention of the subject may therefore be of interest to those engaged in the industry in this country.

Fundamentally the process consists of immersing the article to be frozen in a strong brine which has previously been cooled to, or nearly to, the point where mush ice begins to form in the solution. That the freezing temperature of brine is lower than that of water and that the freezing temperature of the brine is lowered as its saturation point is approached is well known. At present there are at least two processes employing the brine method, one known as the Dahl method, originated by Nekolai Dahl at Trondhjem, Norway, and the other the Ottesen method, by A. Ottesen, Thisted, Denmark.

By the Dahl process, the fresh fish are packed in the shipping boxes before being frozen. Cold brine, which has had its temperature lowered, by contact with crushed ice, to a point approaching its freezing point is pumped through the boxes of fish, flowing back through the ice for recooling. By this means the fish are frozen quickly and the boxes may be headed and put in transit at once. The plant consists of (1) a chamber for cracked ice, with compartments so arranged that the brine passes through ice always in a downward direction into a brine compartment; (2) a centrifugal pump which receives the cold brine and discharges it through a delivery hose into the boxes of fish; (3) a freezing platform on which the boxes rest, provided with troughs for conducting the brine back to the ice chambers for recooling.

In the Ottesen plant the fish are placed in perforated, galvanized-iron baskets, which are submerged in the brine, or, if the fish are of large size, they may be suspended in the brine chamber until frozen. In its simplest form the equipment consists of an insulated iron

freezing tank holding the brine and provided with a propeller (or agitator) and guide plates with sluices for circulating the brine, also a carbon-dioxide refrigerating unit; metal baskets for holding the fish in the brine and galvanized-iron ice cans and wash tank complete the equipment.

Among the advantages claimed for the brine-freezing method, mention may be made of the following: (1) Fish can be frozen much more quickly—in one-tenth of the time or less—than in air freezing; (2) brine-frozen fish retain the flavor, appearance, and other qualities of fresh fish; (3) in slow air freezing the tissues are partially broken down through the formation of large ice crystals, while in rapid freezing the ice crystals formed are so small as not to disrupt the muscle fibers; (4) there is no loss of weight in freezing through evaporation; (5) the equipment takes up little space, without the necessity for a special freezing room, and is adaptable for use on fishing vessels; and (6) there is no tendency for the brine to penetrate the fish or for its juices to enter and weaken the brine.

As the Bureau has not conducted exhaustive experiments in the brine freezing of fish it is not prepared to express an opinion with regard to the value of the method or as to its probable place in the industry. The Bureau's Fishery Products Laboratory in Washington is equipped for conducting proper investigations in air and brine freezing to determine the relative merits and defects of the two methods. It is desirous of doing this investigative work as soon as adequate provision can be made therefor.

INVESTIGATIONS IN CANNING FISHERY PRODUCTS IN SOUTHERN CALIFORNIA.

For years the Bureau has been impressed with the need for rendering those engaged in the preservation of fish by canning a larger measure of service, work which promised to make larger supplies of wholesome protein food available to the consumer and to reduce the cost of that which was being produced. In the summer of 1918 it concluded to initiate such investigations on the coast of southern California and to equip a small plant for the purpose. The immediate object of the work was to develop suitable methods for canning some of the neglected or little-used fishes occurring in abundance in that region and to aid the packers in solving their problems and difficulties. After a study of the principal fishing centers it was decided to start the work at San Pedro, where suitable quarters for housing the equipment were obtained, the necessary equipment provided, and the work begun about May 1, 1919.

A study of canning methods in commercial practice revealed wide differences in the processes used. For example, it was found that the time period and temperature of retorting varied in the different plants. Some used compressed air in the retort when cooling; others did not. Some employed superheated steam exhaust boxes; others no exhaust at all. In some instances large driers of considerable length, equipped with traveling chain-belt conveyors, high-power fans, and an elaborate air-distribution system, were in operation; in others short driers, making use of high temperatures, were employed. One canner holds his pack for a period for ageing; another ships the goods as soon as they are put up. The practices

have been developed in many cases at heavy cost without a definite understanding of the underlying principles and adequate control of the results. These factors do not make for uniformity of pack and have added materially to the cost of production and therefore to the price of the product to the ultimate consumer. In addition, some species of fishes which were abundant were not being canned for the lack of development of suitable methods. The two major functions of the work were, therefore, to develop new methods and to establish standard methods which will yield standard products.

The Pacific coast mackerel (*Scomber japonicus*) is present in large numbers on the southern California coast, being particularly abundant from June to December, inclusive. The principal fishing centers are Monterey, San Pedro, and San Diego. Because of the lack of demand, little attention has been given to the development of the fishery, considerable quantities of that brought in going to the reduction works. In 1918 the Bureau conducted experiments in salting this fish, which indicated that in color and flavor it was hardly the equal of the usual run of salt mackerel on the market. Because of its abundance, favorable food qualities, and lack of demand for it for food purposes, the laboratory has given more attention to perfecting methods of canning this fish than to any other. More than 80 different packs have been put up for examination and several methods of promise developed. The packers have been interested in the results achieved to such an extent as to urge the release of the better methods. This has been granted with the understanding that final tests have not been completed. The California pack of mackerel in 1919 exceeded 9,000 cases, and the increasing interest and tendency of the packers to handle this fish indicate a much larger pack in the future.

In addition to the experiments with mackerel, bonito, barracuda, pilchard, sea bass, smelt, the tunas, and yellowtail have received attention, and several hundred packs of the various species are being held in storage for examination at fixed intervals. Among the problems needing solution are the development of means for overcoming the unpleasant odor and taste encountered in packs of bonito and the detinning of the cans in packs of such fishes as the barracuda. The work done and the interest shown by the trade seem but to accentuate the need for a continuation of investigations in this field.

NEW ENGLAND VESSEL FISHERIES.

The vessel fisheries centering at Boston and Gloucester, Mass., and Portland, Me., were in a prosperous condition during the past year, although the total number of trips and the catch were not so large as in the previous year. The decrease in the number of trips was largest at Gloucester. The products landed at Boston fell off 5.55 per cent in quantity and 28.45 per cent in value, at Gloucester 3.78 per cent in quantity and 29.94 per cent in value, and at Portland less than 1 per cent in quantity and 21.76 per cent in value. The fisheries were affected to some extent, no doubt, by the economic changes following the war period and also by unsettled labor conditions. A strike of the fishermen in July and August resulted in a large falling off in the catch landed by the fishing fleet in those months as com-

pared with that usually landed at that time of year. Statistics of these fisheries have been collected by the local agents and published in monthly bulletins, showing, by species and fishing grounds, the quantities and values of fishery products landed by American and Canadian fishing vessels during the year at these ports. Two annual bulletins have been issued, one showing the catch by months and the other by fishing grounds.

The fishing fleet which landed fish at these ports during the calendar year 1919 numbered 523 sail, steam, and gasoline screw vessels, including 25 American and 2 Canadian steam trawlers. These vessels landed at Boston 2,754 trips, aggregating 103,391,370 pounds of fish, valued at $4,713,350; at Gloucester, 2,965 trips, aggregating 71,370,957 pounds, valued at $2,145,592; and at Portland, 2,550 trips, aggregating 21,718,943 pounds, valued at $689,441. The total for the three ports amounted to 8,269 trips, aggregating 196,481,270 pounds of fresh and salted fish, having a value to the fishermen of $7,548,383. This total includes 39 trips, 26 at Boston and 13 at Portland, landed by 9 Canadian fishing vessels, amounting to 3,296,147 pounds of fresh fish, valued at $106,261. Of this quantity 1,191,845 pounds, valued at $53,653, were landed at Boston, and 2,104,302 pounds, valued at $52,608, at Portland. There was a decrease of 12 vessels, 21 trips, and 2,306,602 pounds in the quantity and $112,364 in the value of the products as compared with the previous year. These fish were landed in accordance with an arrangement with the Canadian Government as an emergency war measure granting reciprocal privileges to fishing vessels, by which Canadian fishing vessels were permitted to land their fares at American ports direct from the fishing grounds. Canadian fishing vessels began to utilize this privilege in April, 1918, and the arrangement is still in operation.

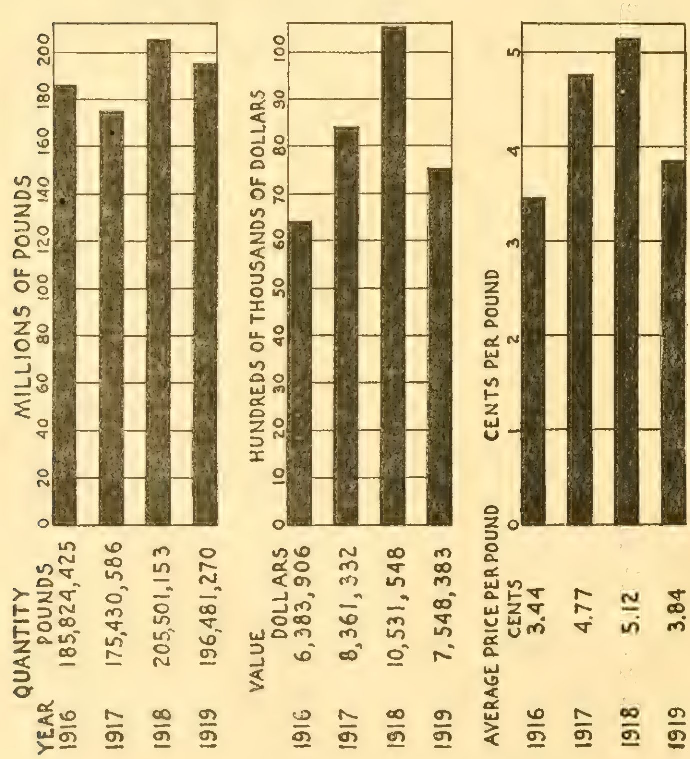
During the year 1919, 24 American fishing vessels landed 29 trips, amounting to 434,486 pounds of fish, at Canadian ports on the Atlantic coast, of which 8 trips by 8 vessels, amounting to 312,036 pounds, were landed at Halifax, Nova Scotia; and 173 American fishing vessels landed 915 trips, amounting to 12,258,522 pounds at Canadian ports on the Pacific coast, of which 889 trips by 154 vessels, amounting to 10,804,522 pounds, were landed at Prince Rupert, British Columbia.

Compared with the previous year, there was a decrease of 481 trips, or 5.49 per cent, in the total number landed by the fishing fleet at Boston, Gloucester, and Portland, and of 9,019,883 pounds, or 4.38 per cent, in the quantity, and $2,983,165, or 28.32 per cent, in the value of the fish landed. The only important species showing an increase in catch over that of the previous year were haddock and halibut. The catch of haddock increased 16,044,644 pounds, or 24.06 per cent, in quantity, but decreased $405,338, or 12.66 per cent, in value, while the catch of halibut increased 333,657 pounds, or 18.73 per cent, in quantity and $84,911, or 28.09 per cent, in value. The cod catch decreased 6,450,007 pounds, or 8.98 per cent, in quantity and $1,034,024, or 28.58 per cent, in value; hake, 941,353 pounds, or 17.82 per cent, in quantity and $92,032, or 33.70 per cent, in value; pollock, 7,808,653 pounds, or 29.39 per cent, in quantity and $581,570, or 60.44 per cent, in value; cusk, 595,062 pounds, or 22.38 per cent, in quantity and $40,862, or 39.65 per cent, in value; mackerel, 4,445,271 pounds, or 43.75 per cent, in quantity and $641,682, or

53.97 per cent, in value; herring, 4,637,077 pounds, or 30.92 per cent, in quantity and $220,894, or 47.94 per cent, in value; swordfish, 151,664 pounds, or 14.66 per cent, in quantity and $10,890, or 4.87 per cent, in value; tilefish, 265,910 pounds, or 88.80 per cent, in quantity and $18,772, or 92.71 per cent, in value; and the various other species combined, 103,187 pounds, or 2.43 per cent, in quantity and $22,012, or 12.12 per cent, in value. The catch of Newfoundland herring decreased 2,885,047 pounds, or 45.17 per cent, in quantity and $142,090, or 42.81 per cent, in value. The quantity of tilefish landed at Boston was very small, amounting to only 33,510 pounds, valued at $1,474, as compared with 299,420 pounds, valued at $20,246, the previous year.

The following graphs present the quantities and values and average price per pound of fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by fishing vessels, and also the number of trips and the average quantity and value of fishery products per trip for the years 1916 to 1919, inclusive.

The following tables present in detail, by fishing grounds and by months, the products landed at Boston and Gloucester, Mass., and Portland, Me., by American and Canadian fishing vessels, for the calendar year 1919. The weights of fresh and salted fish given in these statistics represent the fish as landed from the vessels, and the values are those received by the fishermen. The grades, or sizes, given for certain species are those recognized in the trade.



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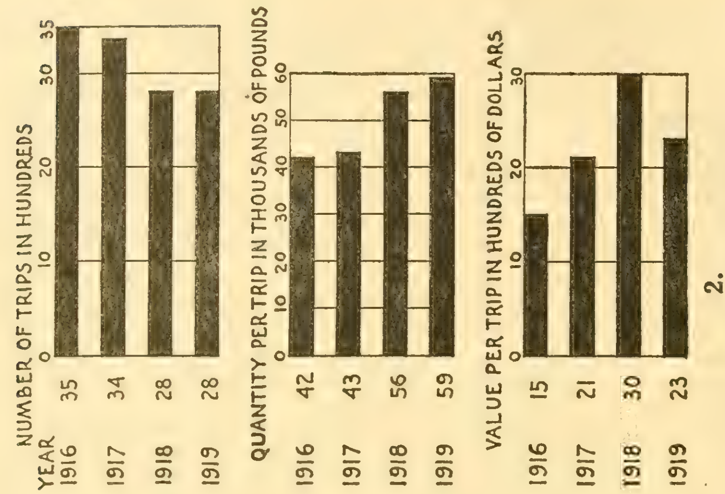

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Fig. 1.—Quantities, values, and average price per pound of fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by fishing vessels for the years 1916 to 1919 inclusive.

Fig. 2.—Number of trips, average quantity and value per trip of fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by fishing vessels from fishing grounds, exclusive of "Shore general," for the years 1916 to 1919 inclusive.

QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY AMERICAN AND CANADIAN FISHING VESSELS, CALENDAR YEAR 1919, BY FISHING GROUNDS.

Fishing grounds.	Number of trips.	Cod.											
		Large (10 pounds and over).				Market (under 10 and over 2½ pounds).				Scrod (1 to 2½ pounds).			
		Fresh.		Salted.		Fresh.		Salted.		Fresh.		Salted.	
LANDED AT BOSTON.													
East of 66° W. longitude.													
By American vessels:		*Pounds*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
La Have Bank	39	655,500	$40,548			368,948	$13,594			8,435	$217		
Western Bank	154	3,523,120	180,958			601,715	20,089			1,570	24		
Quereau Bank	4	62,900	2,491			11,865	356						
Grand Bank	4	34,600	4,852										
Off Newfoundland	1												
Cape Shore	61	203,850	11,953			138,803	5,707			22,949	530		
St. Anns Bank	2	56,000	4,480			95,000	4,750						
By Canadian vessels: Western Bank	2	33,305	2,025			31,200	1,218			250	4		
West of 66° W. longitude.													
By American vessels:													
Browns Bank	89	1,377,935	83,822			771,831	30,444			25,190	605		
Georges Bank	628	11,314,234	528,419			4,170,126	139,646			66,160	1,399		
Cashes Bank	3	9,559	718			4,000	144						
Fippenies Bank	1	9,500	294			9,500	228			200	2		
Middle Bank	138	99,070	6,677			46,930	3,059			11,711	329		
Jeffreys Ledge	80	34,902	3,289			28,505	1,733			5,080	156		
South Channel	395	1,035,811	64,330			1,309,269	46,952			69,574	1,302		
Nantucket Shoals	31	55,703	3,046			180,550	4,866			2,215	41		
Off Highland Light	6	22,000	990			1,750	48			1,000	10		
Off Chatham	335	1,017,710	66,348			938,236	36,966			158,095	2,911		
South	9												
Shore, general	748	427,762	24,918			123,694	5,650			6,020	153		
By Canadian vessels: Georges Bank	24	161,128	9,062			206,090	5,984			6,895	105		
Total	2,754	20,134,589	1,039,220			9,038,012	321,434			385,344	7,788		

QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY AMERICAN AND CANADIAN FISHING VESSELS, CALENDAR YEAR 1919, BY FISHING GROUNDS—Continued.

Fishing grounds.	Number of trips.	Cod.											
		Large (10 pounds and over).				Market (under 10 and over 2½ pounds).				Scrod (1 to 2½ pounds).			
		Fresh.		Salted.		Fresh.		Salted.		Fresh.		Salted.	
		Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
LANDED AT GLOUCESTER.													
East of 66° W. longitude.													
By American vessels:													
La Have Bank	6	39,390	$1,260			32,890	$871			1,860	$28		
Western Bank	192	9,730,135	283,839	2,011,225	$109,532	4,875,219	128,328	969,528	$48,710	82,755	1,233	50,725	$2,198
Quereau Bank	35	2,226,441	63,240	463,281	25,138	1,271,670	30,569	312,688	11,886	8,900	134	27,948	1,156
Green Bank	2	21,820	698	10,800	702	870	23	470	28	180	3		
Grand Bank	15	610,350	18,081	180,688	10,188	84,045	2,182	77,464	2,105	970	15	5,844	261
St. Peters Bank	2			382,235	25,295			195,910	11,755			9,985	462
Burgeo Bank	2	9,630	284	370	19	2,035	48	525	24				
Off Newfoundland	14												
Cape Shore	37	209,094	6,249	1,035	51	89,057	2,358	105	5	5,305	84		
Gulf of St. Lawrence	2												
West of 66° W. longitude.													
By American vessels:													
Browns Bank	4	59,500	1,831			12,720	333			600	12		
Georges Bank	162	3,971,037	129,515	13,785	827	1,850,918	54,326	2,290	126	30,266	594		
South Channel	30	302,570	9,230	2,360	121	304,185	8,178	3,790	172	3,685	50		
Nantucket Shoals	104	16,890	508			91,296	2,257			3,000	45		
Seal Island	1	39,360	1,086										
Shore, general	2,357	1,272,295	51,486			1,900	53			280	4		
Total	2,965	18,508,512	567,307	3,065,779	171,873	8,616,805	229,526	1,562,770	74,811	137,801	2,202	94,502	4,077

LANDED AT PORTLAND.													
East of 66° W. longitude.													
By American vessels:													
La Have Bank	9	72,385	2,527	.....	.....	30,450	785	.....	.....	3,300	34	.....	.....
Western Bank	11	469,720	10,855	.....	.....	136,030	3,196	.....	.....	475	12	.....	.....
Quereau Bank	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Grand Bank	3	3,000	135	.....	.....	1,775	53	.....	.....	.....	.....	.....	.....
St. Peters Bank	2	6,000	260	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Cape Shore	3	4,475	166	.....	.....	4,175	115	.....	.....	345	7	.....	.....
St. Anns Bank	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
By Canadian vessels:													
La Have Bank	3	44,915	1,142	.....	.....	18,500	489	.....	.....	1,335	17	.....	.....
Western Bank	7	451,175	9,946	.....	.....	82,000	1,713	.....	.....	1,375	21	.....	.....
Cape Shore	1	2,210	133	.....	.....	7,450	234	.....	.....	685	10	.....	.....
West of 66° W. longitude.													
By American vessels:													
Browns Bank	1	2,000	90	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Georges Bank	29	143,627	3,646	.....	.....	44,030	998	.....	.....	60	1	.....	.....
Cashes Bank	34	99,885	5,862	.....	.....	38,659	1,248	.....	.....	6,655	83	.....	.....
Platts Bank	25	28,830	1,643	.....	.....	13,330	380	.....	.....	1,260	19	.....	.....
Jeffreys Ledge	49	39,963	2,155	.....	.....	27,535	1,130	.....	.....	5,700	97	.....	.....
South Channel	12	133,639	2,913	.....	.....	15,900	427	.....	.....	.....	.....	.....	.....
Shore, general	2,355	1,354,923	89,729	.....	.....	455,101	20,876	208	6	77,226	1,790	.....	.....
By Canadian vessels:													
Browns Bank	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Georges Bank	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total	2,550	2,856,747	131,202	.....	.....	874,935	31,644	208	6	98,416	2,091	.....	.....
Grand total	8,269	41,499,848	1,737,729	3,065,779	171,873	18,529,752	582,604	1,562,978	74,817	621,561	12,081	94,502	4,077

QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY AMERICAN AND CANADIAN FISHING VESSELS, CALENDAR YEAR 1919, BY FISHING GROUNDS—Continued.

Fishing grounds.	Haddock.						Hake.							
	Large (over 2½ pounds).				Scrod (1 to 2½ pounds).		Large (6 pounds and over).				Small (under 6 pounds).			
	Fresh.		Salted.		Fresh.		Fresh.		Salted.		Fresh.		Salted.	
LANDED AT BOSTON.														
East of 66° W. longitude.														
By American vessels:	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
La Have Bank	809,530	$35,324			1,650	$83	59,170	$3,536			62,550	$2,245		
Western Bank	2,230,200	84,479			15,500	346	15,030	913			67,055	2,937		
Quereau Bank							24,585	963						
Cape Shore	571,723	33,181			3,400	118	12,540	730			17,285	794		
St. Anns Bank	59,000	4,130												
By Canadian vessels: Western Bank.	115,600	4,418			19,500	536								
West of 66° W. longitude.														
By American vessels:														
Browns Bank	1,564,245	70,530			6,640	299	11,340	454			37,840	1,461		
Georges Bank	17,481,210	611,385			1,010,778	31,657	37,780	1,567			62,380	2,469		
Cashes Bank	320	6					800	58			5,420	232		
Fippenies Bank	7,925	315												
Middle Bank	859,345	54,585			19,430	956	65,008	5,333			232,705	14,498		
Jeffreys Ledge	235,520	18,600			6,745	319	21,110	1,939			152,035	8,150		
South Channel	23,656,183	875,841			1,080,091	20,920	334,963	13,666			502,372	16,177		
Nantucket Shoals	538,140	13,421			1,215	13	4,080	163			4,995	134		
Off Chatham	6,813,869	290,716			47,225	1,471	209,695	9,879			309,468	13,860		
South											2,105	113		
Shore, general	149,112	7,926			2,965	103	12,278	505			41,718	1,650		
By Canadian vessels: Georges Bank	465,028	23,294			76,115	3,065								
Total	55,556,950	2,128,151			2,291,254	59,886	808,379	39,706			1,497,928	64,720		

LANDED AT GLOUCESTER.														
East of 66° W. longitude.														
By American vessels:														
La Have Bank	82,685	1,447					18,635	358						
Western Bank	4,548,244	88,349	133,125	$5,449	245,391	2,871	257,069	5,373	16,570	$562				
Quereau Bank	812,013	16,416	15,823	566			25,590	513	13,800	414	500	8		
Grand Bank	108,640	1,901	5,694	206	36,085	541	47,405	1,026	8,000	261				
St. Peters Bank			70	3										
Cape Shore	131,655	2,696					17,520	347						
West of 66° W. longitude.														
By American vessels:														
Browns Bank	115,105	1,850												
Georges Bank	6,373,318	129,025			128,535	1,544	136,410	3,035	700	32				
South Channel	1,658,785	35,606	450	16	22,630	226	5,225	131						
Nantucket Shoals	688,845	11,423			105,780	1,536	3,165	55						
Seal Island							10,550	185						
Shore, general	2,631,087	107,436					224,528	13,107						
Total	17,150,377	396,149	155,162	6,240	538,421	6,718	746,097	24,130	39,070	1,269	500	8		
LANDED AT PORTLAND.														
East of 66° W. longitude.														
By American vessels:														
La Have Bank	144,320	4,087			5,775	63	1,265	37			4,130	159		
Western Bank	1,972,624	44,485			15,875	159					7,930	172		
Grand Bank							1,675	50						
St. Peters Bank							1,165	34						
Cape Shore	540	16					530	21			2,800	71		
By Canadian vessels:														
La Have Bank	105,830	2,697			280	4					2,320	46		
Western Bank	1,285,585	28,390			1,265	19	860	43			1,250	38		
Cape Shore	27,475	893			380	6	210	4			975	20		
West of 66° W. longitude.														
By American vessels:														
Georges Bank	1,052,442	22,238					365	33			7,755	348		
Cashes Bank	8,672	578			1,060	22	16,087	1,015			60,530	2,425		
Platts Bank	2,849	178					12,413	743			113,746	3,851		
Jeffreys Ledge	321,325	11,866			13,613	321	10,675	722			113,230	4,459		
South Channel	1,281,829	29,315					3,120	125			3,800	95		
Shore, general	751,272	50,440			31,009	1,017	140,522	9,107			739,699	27,587	450	$15
Total	6,954,764	195,183			69,257	1,611	188,887	11,934			1,058,165	39,271	450	15
Grand total	79,662,091	2,719,483	155,162	6,240	2,898,932	68,215	1,743,363	75,770	39,070	1,269	2,556,593	103,999	450	15

QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY AMERICAN AND CANADIAN FISHING VESSELS, CALENDAR YEAR 1919, BY FISHING GROUNDS—Continued.

Fishing grounds.	Pollock.				Cusk.				Halibut.			
	Fresh.		Salted.		Fresh.		Salted.		Fresh.		Salted.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
LANDED AT BOSTON.												
East of 66° W. longitude.												
By American vessels:												
La Have Bank	29,770	$1,359			139,927	$3,944			63,676	$14,838		
Western Bank	305,348	7,916			65,098	1,981			321,852	56,825		
Quereau Bank	2,190	66			25,940	818			33,181	7,973		
Grand Bank									105,000	21,100		
Off Newfoundland									40,000	6,000		
Cape Shore	6,760	310			19,425	544			6,087	1,474		
By Canadian vessels: Western Bank	4,550	214							52	13		
West of 66° W. longitude.												
By American vessels:												
Browns Bank	88,165	3,633			258,521	7,680			139,021	28,691		
Georges Bank	628,986	22,488			47,660	1,494			497,923	90,833		
Cashes Bank	1,120	40			9,900	241			1,693	277		
Fippenies Bank	230	3			4,600	79			350	53		
Middle Bank	25,882	1,713			54,535	2,231			2,353	746		
Jeffreys Ledge	286,145	9,978			55,800	2,046			1,833	470		
South Channel	312,001	9,777			22,605	686			65,355	12,426		
Nantucket Shoals	112,265	2,810			400	10			1,462	279		
Off Highland Light	900	36										
Off Chatham	358,860	16,755			19,663	728			20,308	4,661		
Shore, general	788,126	26,202			11,355	479			23,159	2,270	2,000	$320
By Canadian vessels: Georges Bank	49,483	1,736			1,225	25			6,079	1,180		
Total	3,000,781	105,036			736,654	22,986			1,329,384	250,112	2,000	320
LANDED AT GLOUCESTER.												
East of 66° W. longitude.												
By American vessels:												
La Have Bank	3,085	49			87,500	1,844						
Western Bank	496,122	8,817	46,439	$1,141	252,995	5,566	33,110	$1,475	166,629	22,266	6,983	959
Quereau Bank	58,423	952	5,993	161	11,630	286	145	6	50,596	7,764	3,164	41
Green Bank							685	31	79,373	13,672		
Grand Bank	3,124	59	1,854	61	10,952	251	4,022	146	49,234	8,990	218	39
St. Peters Bank			815	37							2,205	353
Cape Shore	5,055	68			68,630	1,351						

West of 66° W. longitude.												
By American vessels:												
Browns Bank	610	11			42,195	886						
Georges Bank	143,244	2,905			124,065	2,974			11,578	2,115		
South Channel	21,525	477			420	11						
Nantucket Shoals	3,128,700	42,904										
Seal Island	310	5			2,300	52						
Shore, general	10,738,588	191,958			8,270	152			50	13		
Total	14,598,786	248,205	55,101	1,400	608,957	13,373	37,962	1,658	357,460	54,820	12,600	1,770
LANDED AT PORTLAND.												
East of 66° W. longitude.												
By American vessels:												
La Have Bank	2,755	62			21,540	659			67,498	13,219		
Western Bank	81,095	1,147			4,240	122			50,692	8,430		
Quereau Bank									19,970	5,041		
Grand Bank									67,864	14,492		
St. Peters Bank									59,017	11,952		
Cape Shore	80	2			2,590	56			741	96		
By Canadian vessels:												
La Have Bank	535	12			17,165	377			3,940	647		
Western Bank	9,780	104			745	15			1,464	232		
Cape Shore	110	2			7,240	142			3,629	647		
West of 66° W. longitude.												
By American vessels:												
Browns Bank									20,191	4,145		
Georges Bank	1,805	59			10,430	283			83,635	14,222		
Cashes Bank	6,711	172			110,883	3,032			17,012	3,356		
Platts Bank	840	21			71,688	1,982			1,503	366		
Jeffreys Ledge	18,158	671			62,158	2,258			1,212	207		
South Channel	3,495	42							2,266	515		
Shore, general	971,420	23,565	515	15	370,946	15,225			12,583	2,602		
Total	1,096,784	25,859	515	15	679,625	24,152			413,217	80,169		
Grand total	18,696,351	379,100	55,616	1,415	2,025,236	60,511	37,962	1,658	2,100,061	385,101	14,600	2,090

QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY AMERICAN AND CANADIAN FISHING VESSELS, CALENDAR YEAR 1919, BY FISHING GROUNDS—Continued.

Fishing grounds.	Mackerel.											
	Large (over 2¼ pounds).				Medium (1½ to 2¼ pounds).				Small (under 1½ pounds).			
	Fresh.		Salted.		Fresh.		Salted.		Fresh.		Salted.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
LANDED AT BOSTON.												
East of 66° W. longitude.												
By American vessels: Cape Shore..	1,931,977	$118,300	166,000	$13,556	60,285	$3,617	....	....	....	....	....	....
West of 66° W. longitude.												
By American vessels:												
Georges Bank..........	....	....	....	....	14,450	1,301	....	....	500	$35	....	....
Middle Bank..........	8,350	1,678	....	....	....	....	....	....	395,565	34,626	....	....
South Channel..........	7,125	1,069	....	....	....	....	....	....	....	....	....	....
Nantucket Shoals..........	24,635	3,597	....	....	....	....	....	....	....	....	....	....
Off Highland Light..........	30,851	6,496	....	....	....	....	....	....	181	18	....	....
Off Chatham..........	59,560	10,532	....	....	16,260	1,616	....	....	120,832	11,949	....	....
South..........	60,380	4,079	....	....	19,200	808	....	....	150	2	....	....
Shore, general..........	498,203	91,991	....	....	68,930	6,557	....	....	546,550	61,389	3,200	$442
Total..........	2,621,081	237,742	166,000	13,556	179,125	13,899	....	....	1,063,778	108,019	3,200	442
LANDED AT GLOUCESTER.												
East of 66° W. longitude.												
By American vessels:												
Cape Shore..........	65,381	5,639	1,094,763	89,784	....	....	....	....	....	....	....	....
Gulf of St. Lawrence..........	....	....	34,000	6,246	....	....	....	....	....	....	....	....
West of 66° W. longitude.												
By American vessels:												
Nantucket Shoals..........	1,232	98	46,996	5,037	....	....	....	....	3,218	129	25,000	1,698
Shore, general..........	154,516	28,474	8,200	1,156	1,035	98	6,400	$950	18,680	709	9,288	840
Total..........	221,129	34,211	1,183,959	102,223	1,035	98	6,400	950	21,898	838	34,288	2,538

LANDED AT PORTLAND												
East of 66° W. longitude.												
By American vessels: Cape Shore...	19,785	1,032	3,000	240	....	....	....	....	....	....	....	....
West of 66° W. longitude.												
By American vessels: Shore, general.	168,265	28,849	1,559	187	12,800	1,461	....	....	5,874	955	20	2
Total........................	188,050	29,881	4,559	427	12,800	1,461	....	....	5,874	955	20	2
Grand total..................	3,030,260	301,834	1,354,518	116,206	192,960	15,458	6,400	950	1,091,550	109,812	37,508	2,982

QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY AMERICAN AND CANADIAN FISHING VESSELS, CALENDAR YEAR 1919, BY FISHING GROUNDS—Continued.

Fishing grounds.	Miscellaneous.				Total.				Grand total.	
	Fresh.		Salted.		Fresh.		Salted.			
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
LANDED AT BOSTON.										
East of 66° W. longitude.										
By American vessels:										
La Have Bank	24,960	$1,223			2,224,116	$116,911			2,224,116	$116,911
Western Bank	43,651	1,600			7,190,139	358,068			7,190,139	358,068
Quereau Bank	1,625	125			162,286	12,792			162,286	12,792
Grand Bank	315	110			139,915	26,062			139,915	26,062
Off Newfoundland					40,000	6,000			40,000	6,000
Cape Shore	80,748	17,519			3,075,832	194,777	166,000	$13,556	3,241,832	208,333
St. Anns Bank	2,400	108			212,400	13,468			212,400	13,468
By Canadian vessels: Western bank	350	29			204,807	8,457			204,807	8,457
West of 66° W. longitude.										
By American vessels:										
Browns Bank	69,917	2,769			4,350,645	230,391			4,350,645	230,391
Georges Bank	900,978	148,415	11,400	$285	36,233,165	1,581,108	11,400	285	36,244,565	1,581,393
Cashes Bank	800	20			33,612	1,736			33,612	1,734
Fippenies Bank					32,305	974			32,305	974
Middle Bank	123,921	5,013			1,944,805	131,444			1,944,805	131,449
Jeffreys Ledge	67,922	3,849			895,597	50,529			895,597	50,526
South Channel	558,966	25,424			28,954,315	1,088,570			28,954,315	1,088,570
Nantucket Shoals	67,391	1,467			993,051	29,847			993,051	29,847
Off Highland Light	979	117			57,661	7,715			57,661	7,715
Off Chatham	399,477	14,581			10,489,258	482,973			10,489,258	482,973
South	34,655	1,555			116,490	6,557			116,490	6,557
Shore, general	2,171,461	75,379			4,871,333	305,172	5,200	762	4,876,533	305,934
By Canadian vessels: Georges Bank	14,995	745			987,038	45,196			987,038	45,196
Total	4,565,511	300,048	11,400	285	103,208,770	4,698,747	182,600	14,603	103,391,370	4,713,350
LANDED AT GLOUCESTER.										
East of 66° W. longitude.										
By American vessels:										
La Have Bank					266,045	5,857			266,045	5,857
Western Bank					20,654,559	546,642	3,267,705	170,026	23,922,264	716,668
Quereau Bank					4,465,763	119,882	842,842	39,746	5,308,605	159,628
Green Bank					102,243	14,396	11,955	761	114,198	15,157
Grand Bank					950,805	33,046	283,814	13,267	1,234,619	46,313
St. Peters Bank							591,220	37,905	591,220	37,905
Burgeo Bank					11,665	332	895	43	12,560	375

Off Newfoundland			[1]3,501,777	189,783			3,501,777	189,783	3,501,777	189,783
Cape Shore					591,697	18,792	1,095,903	89,840	1,687,600	108,632
Gulf of St. Lawrence							34,000	6,246	34,000	6,246
West of 66° W. longitude.										
By American vessels:										
Browns Bank					230,730	4,923			230,730	4,923
Georges Bank	36,292	6,918			12,805,663	332,951	16,775	985	12,822,438	333,936
South Channel					2,319,025	53,909	6,600	309	2,325,625	54,218
Nantucket Shoals					4,042,126	58,955	71,996	6,735	4,114,122	65,690
Seal Island					52,520	1,328			52,520	1,328
Shore, general	77,517	2,497			15,128,746	395,987	23,888	2,946	15,152,634	398,933
Total	113,809	9,415	3,501,777	189,783	61,621,587	1,587,000	9,749,370	558,592	71,370,957	2,145,592
LANDED AT PORTLAND.										
East of 66° W. longitude.										
By American vessels:										
La Have Bank	17,653	2,268			371,071	23,900			371,071	23,900
Western Bank	595	11			2,739,277	68,589			2,739,277	68,589
Quereau Bank					19,970	5,041			19,970	5,041
Grand Bank					74,314	14,730			74,314	14,730
St. Peters Bank					66,182	12,246			66,182	12,246
Cape Shore					36,061	1,582	3,000	240	39,061	1,822
St. Anns Bank	15,479	3,734			15,479	3,734			15,479	3,734
By Canadian vessels:										
La Have Bank					194,820	5,431			194,820	5,431
Western Bank					1,835,499	40,521			1,835,499	40,521
Cape Shore					50,364	2,092			50,364	2,092
West of 66° W. longitude.										
By American vessels:										
Browns Bank					22,191	4,235			22,191	4,235
Georges Bank	191,961	42,967			1,536,110	84,795			1,536,110	84,795
Cashes Bank	1,586	23			367,740	17,816			367,740	17,816
Platts Bank	1,750	21			248,209	9,204			248,209	9,204
Jeffreys Ledge	13,878	338			627,447	24,224			627,447	24,224
South Channel	5,695	100			1,449,744	33,532			1,449,744	33,532
Shore, general	6,943,454	59,537			12,035,094	332,740	2,752	225	12,037,846	332,965
By Canadian vessels:										
Browns Bank	9,751	1,288			9,751	1,288			9,751	1,288
Georges Bank	13,868	3,276			13,868	3,276			13,868	3,276
Total	7,215,670	113,563			21,713,191	688,976	5,752	465	21,718,943	689,441
Grand total	11,894,990	423,026	3,513,177	190,068	186,543,518	6,974,723	9,937,722	573,660	196,481,270	7,548,383

[1] Herring. Other items under "Miscellaneous" include bluebacks, 27,450 pounds, value $304; bonito, 780 pounds, value $57; butterfish, 11,312 pounds, value $1,132; catfish or wolffish, 98,378 pounds, value $2,893; eels, 310 pounds, value $12; flounders, 2,451,856 pounds, value $103,050; goosefish, 200 pounds, value $3; herring, 6,858,108 pounds, value $50,005 horse mackerel, 560 pounds, value $50; redfish, 54,685 pounds, value $1,516; salmon, 7 pounds, value $2; shad, 222,612 pounds, value $8,643; sharks, 26,786 pounds, value $837; skates, 11,930 pounds, value $252; smelt, 27,012 pounds, value $2,503; sturgeon, 3,058 pounds, value $582; swordfish, 882,727 pounds, value $212,368; tilefish, 33,510 pounds, value $1,474; whiting, 43,110 pounds, value $231; porpoise, 70 pounds, value $2; lobster, 172 pounds, value $63; shrimp, 300 pounds, value $39; livers, 895,595 pounds, value $25,315; sounds, 127 pounds, value $3; spawn, fresh, 242,135 pounds, value $11,635; spawn, salted, 11,400 pounds, value $285; and tongues, 2,200 pounds, value $55.

QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY AMERICAN AND CANADIAN FISHING VESSELS DURING 1919,[1] BY MONTHS.

Fishing grounds.	Number of trips.	Cod.											
		Large (10 pounds and over).				Market (under 10 and over 2½ pounds).				Scrod (1 to 2½ pounds).			
		Fresh.		Salted.		Fresh.		Salted.		Fresh.		Salted.	
		Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
LANDED AT BOSTON.													
January	244	1,305,953	$95,998			673,614	$36,726			75,056	$1,946		
February	207	2,602,759	115,003			494,167	19,178			27,535	601		
March	242	4,388,311	169,499			696,206	25,471			19,145	398		
April	232	2,180,083	116,679			557,993	21,400			50,543	860		
May	243	1,622,654	68,263			989,033	24,705			41,900	579		
June	253	1,502,250	77,476			1,397,223	39,249			46,885	509		
July	119	526,835	23,532			301,120	7,971			5,605	60		
August	120	140,259	13,963			224,155	13,481			13,755	477		
September	323	1,620,836	94,578			1,034,702	36,876			23,645	568		
October	322	1,889,581	104,120			1,074,160	34,720			33,305	696		
November	246	1,528,525	96,757			896,674	32,976			22,162	504		
December	203	826,543	63,352			698,965	28,681			25,808	590		
Total	2,754	20,134,589	1,039,220			9,038,012	321,434			385,344	7,788		
LANDED AT GLOUCESTER.													
January	156	69,311	3,757	90	$7	62,255	2,441	25	$2	3,340	67		
February	100	453,870	15,476			52,385	1,571			480	8		
March	254	1,906,571	62,593	7,670	349	257,175	6,970	1,200	42	11,250	301		
April	430	1,368,098	44,229	16,530	909	480,525	12,071	2,040	92	11,601	217		
May	317	4,634,207	132,907	25,290	1,084	1,925,971	47,538	6,245	243	25,255	390		
June	148	3,420,819	94,268	958,765	51,894	2,102,140	53,448	420,575	20,772	57,665	850	9,085	$358
July	84	2,551,921	70,803	400,073	21,666	1,040,628	25,159	257,653	11,765	5,710	81	21,659	873
August	8	69,930	2,100	751,447	33,574	51,260	1,398	441,586	15,459	260	3	33,101	1,444
September	102	1,317,933	47,405	429,485	28,304	1,265,955	34,808	247,160	14,764	4,620	64	25,985	1,182
October	600	2,009,975	67,756	444,759	32,028	1,088,515	36,242	183,986	11,534	7,770	93	4,672	220
November	530	605,527	21,603	11,340	737	239,981	6,626	400	24	3,970	54		
December	236	100,350	4,410	20,330	1,321	50,015	1,254	1,900	114	5,880	74		
Total	2,965	18,508,512	567,307	3,065,779	171,873	8,616,805	229,526	1,562,770	74,811	137,801	2,202	94,502	4,077

LANDED AT PORTLAND.													
January	182	103,379	6,429	...	...	69,171	4,829	...	...	17,653	593	...	...
February	183	100,853	4,703	...	...	64,597	2,741	...	...	9,944	224	...	...
March	251	233,323	8,376	...	...	71,100	3,170	...	...	8,992	175	...	...
April	295	223,820	10,084	...	...	333,964	8,695	...	...	13,616	256	...	...
May	286	577,498	14,199	...	...	47,459	1,050	...	...	5,057	56	...	...
June	275	801,219	23,851	...	...	68,224	1,685	...	...	4,648	54	...	...
July	273	368,959	28,600	...	...	26,427	1,039	...	...	3,838	49	...	...
August	262	206,494	19,062	...	...	47,469	2,363	...	...	2,792	55	...	...
September	145	80,054	5,134	...	...	17,264	712	208	6	2,951	50	...	...
October	202	68,028	3,849	...	...	42,206	1,382	...	...	4,037	67	...	...
November	97	38,156	2,246	...	...	30,738	1,107	...	...	5,336	87	...	...
December	99	54,964	4,669	...	...	56,316	2,871	...	...	19,552	425	...	...
Total	2,550	2,856,747	131,202	...	...	874,935	31,644	208	6	98,416	2,091	...	...
Grand total	8,269	41,499,848	1,737,729	3,065,779	171,873	18,529,752	582,604	1,562,978	74,817	621,561	12,081	94,502	4,077
Grounds E. of 66° W. long	617	18,470,015	646,122	3,049,634	170,925	7,883,697	216,678	1,556,690	74,513	140,689	2,373	94,502	4,077
Grounds W. of 66° W. long	7,652	23,029,833	1,091,607	16,145	948	10,646,055	365,926	6,288	304	480,872	9,708	...	...
Landed at Boston in 1918	2,830	21,849,086	1,453,212	...	...	12,674,977	635,575	35,000	1,400	1,397,026	34,055	...	...
Landed at Gloucester in 1918	3,414	17,059,266	701,261	1,945,048	138,727	10,806,656	341,717	1,386,633	88,961	376,608	7,596	115,235	7,895
Landed at Portland in 1918	2,506	2,745,657	143,071	2,105	163	1,242,403	57,580	1,712	146	185,900	5,786	1,115	60

[1] These statistics for 1919 include 39 trips landed by Canadian fishing vessels, 26 at Boston and 13 at Portland, amounting to 3,296,147 pounds of fish, value $106,261.

QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY AMERICAN AND CANADIAN FISHING VESSELS DURING 1919, BY MONTHS—Continued.

Fishing grounds.	Haddock.								Hake.							
	Large (over 2½ pounds).				Scrod (1 to 2½ pounds).				Large (6 pounds and over).				Small (under 6 pounds).			
	Fresh.		Salted.		Fresh.		Salted.		Fresh.		Salted.		Fresh.		Salted.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
LANDED AT BOSTON.																
January	4,362,153	$273,283			353,035	$16,722			35,628	$4,411			243,170	$16,386		
February	5,127,677	207,402			169,513	5,497			8,580	922			65,010	4,480		
March	8,032,356	244,703			353,810	8,374			10,835	645			67,265	2,779		
April	6,019,243	161,535			589,560	13,130			8,120	436			74,580	2,830		
May	3,594,553	108,012			269,986	3,417			18,780	837			82,935	2,403		
June	3,370,891	95,818			185,485	2,646			19,965	569			95,335	2,797		
July	919,570	23,905			22,525	322			54,255	1,789			20,820	561		
August	1,830,845	85,735			26,160	1,114			48,375	2,677			70,850	3,496		
September	5,368,750	177,110			60,710	1,718			103,633	4,228			117,483	4,434		
October	7,385,364	229,089			170,095	4,294			290,185	10,318			256,637	7,830		
November	4,581,570	249,716			71,175	1,948			144,903	8,710			257,415	9,998		
December	4,963,978	271,843			19,200	704			65,120	4,164			146,428	6,726		
Total	55,556,950	2,128,151			2,291,254	59,886			808,379	39,706			1,497,928	64,720		
LANDED AT GLOUCESTER.																
January	104,423	4,066							700	21	335	$15				
February	450,022	21,243							215	4						
March	2,500,942	74,133			48,335	611			1,384	28	1,200	36				
April	2,635,398	62,106			18,145	181			4,290	86	2,620	79	500	8		
May	1,710,289	31,073			184,560	2,642			73,305	1,375						
June	1,960,125	34,624	11,070	$387	255,356	2,964			32,665	567	2,140	59				
July	827,785	14,470	17,657	617	32,025	320			87,185	1,526	155	4				
August	64,480	1,451	25,691	954					1,265	32	3,800	133				
September	3,479,268	78,069	64,015	2,876					122,785	3,021	980	45				
October	3,064,825	66,062	36,729	1,406					185,105	4,116	25,860	839				
November	286,535	5,731							187,863	10,597	980	29				
December	66,285	3,121							49,335	2,757	1,000	30				
Total	17,150,377	396,149	155,162	6,240	538,421	6,718			746,097	24,130	39,070	1,269	500	8		

LANDED AT PORTLAND.																
January	170,011	16,614	....	......	7,850	390	....	......	11,510	1,278	....	......	67,661	3,981	....	......
February	261,223	12,712	....	......	9,496	272	....	......	18,626	1,834	....	......	147,580	7,517	....	......
March	1,105,627	29,889	....	......	18,220	335	....	......	16,518	1,268	....	......	130,377	4,918	....	......
April	1,430,030	33,321	....	......	3,516	77	....	......	24,283	1,629	....	......	160,186	6,087	....	......
May	1,961,603	45,483	....	......	1,777	31	....	......	18,423	771	....	......	94,984	2,044	....	......
June	1,308,603	30,236	....	......	1,803	40	....	......	11,833	323	....	......	55,827	974	....	......
July	426,512	10,635	....	......	17,220	211	....	......	22,343	1,171	....	......	56,832	1,939	....	......
August	17,548	1,458	....	......	1,261	40	....	......	14,687	944	....	......	84,727	3,228	....	......
September	32,008	1,729	....	......	1,885	28	....	......	11,152	627	....	......	51,359	1,712	....	......
October	103,180	3,389	....	......	1,695	26	....	......	22,990	1,052	....	......	100,902	2,788	450	$15
November	49,562	2,768	....	......	1,170	36	....	......	7,852	516	....	......	69,033	2,653	....	......
December	88,857	6,949	....	......	3,364	125	....	......	8,670	521	....	......	38,697	1,430	....	......
Total	6,954,764	195,183	....	......	69,257	1,611	....	......	188,887	11,934	....	......	1,058,165	39,271	450	15
Grand total	79,662,091	2,719,483	155,162	6,240	2,898,932	68,215	....	......	1,743,363	75,770	39,070	1,269	2,556,593	103,999	450	15
Grounds E. of 66° W. long	13,005,665	352,909	154,712	6,224	345,101	4,746	....	......	483,249	13,948	38,370	1,237	166,795	6,490	....	......
Grounds W. of 66° W. long	66,656,426	2,366,574	450	16	2,553,831	63,469	....	......	1,260,114	61,822	700	32	2,389,798	97,509	450	15
Landed at Boston in 1918	46,140,828	2,449,932	....	......	6,044,978	225,335	....	......	986,743	67,897			2,015,567	103,706	....	......
Landed at Gloucester in 1918	7,924,068	249,512	52,853	2,645	461,590	14,808	15,639	$856	533,499	17,319	33,767	1,385	150	3	460	25
Landed at Portland in 1918	5,959,531	253,142	....	......	72,054	3,046	....	......	314,036	22,463	740	33	1,395,867	60,254	....	......

QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY AMERICAN AND CANADIAN FISHING VESSELS DURING 1919, BY MONTHS—Continued.

Fishing grounds.	Pollock.				Cusk.				Halibut.			
	Fresh.		Salted.		Fresh.		Salted.		Fresh.		Salted.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
LANDED AT BOSTON.												
January	98,480	$7,441			149,978	$6,200			28,093	$9,903		
February	69,202	4,450			23,848	1,098			74,619	17,753		
March	32,226	1,830			23,100	939			59,672	13,973		
April	90,729	3,555			134,660	3,067			260,115	42,662		
May	348,181	8,875			61,445	1,424			246,976	35,409		
June	263,587	9,556			14,780	351			154,391	25,500		
July	30,213	917			28,890	899			114,594	17,422		
August	75,642	5,897			3,550	147			7,222	1,337	2,000	$320
September	496,620	18,886			39,250	1,458			108,649	20,385		
October	571,492	14,619			50,907	1,645			216,570	49,946		
November	791,784	25,028			62,960	1,794			31,556	7,861		
December	129,625	3,982			143,286	3,964			26,927	7,961		
Total	3,000,781	105,036			736,654	22,986			1,329,384	250,112	2,000	320
LANDED AT GLOUCESTER.												
January	475,445	29,886			3,187	98			35,889	6,747		
February	29,390	1,842			4,305	109			56,789	8,358	85	3
March	71,273	3,773			920	19	400	$12	12,780	2,055		
April	155,815	5,024	1,135	$26	92,100	1,785	275	10	72,531	11,743		
May	2,992,329	41,346	45	1	144,865	2,926			56,447	6,599	635	29
June	96,605	1,284	18,880	472	10,265	212	530	16	9,808	1,093	2,010	311
July	198,710	2,389	3,560	103	119,375	2,568	640	22	58,611	8,087	1,722	269
August	3,356	113	16,956	234			1,517	56			2,911	448
September	179,520	4,324	7,985	360	94,430	2,330	31,745	1,429	8,508	1,640	2,285	366
October	5,015,795	76,620	6,540	204	89,340	2,226	2,055	77	320	37	2,952	344
November	4,157,215	61,314			39,465	874	65	3	24,441	4,490		
December	1,223,333	20,290			10,705	226	735	33	21,336	3,971		
Total	14,598,786	248,205	55,101	1,400	608,957	13,373	37,962	1,658	357,460	54,820	12,600	1,770

LANDED AT PORTLAND.												
January	24,530	1,607			44,825	2,862			420	91		
February	23,501	1,386			101,480	3,744			4,046	714		
March	30,573	1,387			72,300	3,254			2,085	390		
April	355,906	7,449			157,977	4,453			8,304	1,794		
May	121,207	1,539			50,120	1,057			7,244	1,207		
June	114,640	1,397			32,711	1,015			132,339	21,398		
July	26,259	767			38,843	1,077			47,495	8,101		
August	39,490	2,083			23,417	1,055			3,329	881		
September	60,594	1,994	515	15	47,464	1,577			65,341	13,632		
October	274,322	5,410			52,226	1,534			106,256	22,520		
November	18,668	589			29,500	1,168			891	154		
December	7,094	251			28,762	1,356			35,467	9,287		
Total	1,096,784	25,859	515	15	679,625	24,152			413,217	80,169		
Grand total	18,696,351	379,100	55,616	1,415	2,025,236	60,511	37,962	1,658	2,100,061	385,101	14,600	2,090
Grounds E. of 66° W. long	1,008,782	21,139	55,101	1,400	735,617	17,957	37,962	1,658	1,190,495	215,671	12,600	1,770
Grounds W. of 66° W. long	17,687,569	357,961	515	15	1,289,619	42,554			909,566	169,430	2,000	320
Landed at Boston in 1918	4,291,471	250,269			1,088,403	44,682			686,955	134,654		
Landed at Gloucester in 1918	20,747,802	661,812	53,258	2,092	677,598	20,305	13,940	593	771,664	110,508	10,931	1,240
Landed at Portland in 1918	1,468,089	47,912			878,319	37,451			311,454	55,878		

QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY AMERICAN AND CANADIAN FISHING VESSELS DURING 1919, BY MONTHS—Continued.

Fishing grounds.	Mackerel.											
	Large (over 2¼ pounds).				Medium (1½ to 2¼ pounds).				Small (under 1½ pounds).			
	Fresh.		Salted.		Fresh.		Salted.		Fresh.		Salted.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
LANDED AT BOSTON.												
January												
February												
March												
April												
May					26,300	$1,841						
June	2,087,895	$132,131	166,000	$13,556	95,870	5,668			24,650	$1,703		
July	14,473	2,735			6,000	240			135,480	6,489		
August	99,990	20,608			50,955	6,150			11,351	1,279		
September	43,397	7,043							863,614	91,894	3,200	$442
October	203,839	38,996							28,683	6,654		
November	171,487	36,229										
December												
Total	2,621,081	237,742	166,000	13,556	179,125	13,899			1,063,778	108,019	3,200	442
LANDED AT GLOUCESTER.												
January												
February												
March												
April												
May												
June	65,381	5,639	1,094,763	89,784	835	75					5,700	338
July	1,232	98	46,996	5,037					21,898	838	25,000	1,698
August												
September	1,500	210	7,400	1,036			1,000	$140			388	54
October	68,976	12,727	800	120	200	23	5,400	810			3,200	448
November	84,040	15,537	34,000	6,246								
December												
Total	221,129	34,211	1,183,959	102,223	1,035	98	6,400	950	21,898	838	34,288	2,538

LANDED AT PORTLAND.												
January												
February												
March												
April												
May	4	1										
June	23,356	1,399	4,369	404	467	37					20	2
July	2,274	348			7,628	816			1,351	187		
August	80,964	14,338			3,348	341			4,293	730		
September	67,417	10,610			457	87			90	16		
October	10,155	2,487	190	23	900	180			140	22		
November	3,880	698										
December												
Total	188,050	29,881	4,559	427	12,800	1,461			5,874	955	20	2
Grand total	3,030,260	301,834	1,354,518	116,206	192,960	15,458	6,400	950	1,091,550	109,812	37,508	2,982
Grounds E. of 66° W. long.	2,017,143	124,971	1,297,763	109,826	60,285	3,617						
Grounds W. of 66° W. long.	1,013,117	176,863	56,755	6,380	132,675	11,841	6,400	950	1,091,550	109,812	37,508	2,982
Landed at Boston in 1918	4,995,826	549,741	174,400	23,988	1,261,360	171,509	30,220	4,479	308,427	31,287	9,400	1,504
Landed at Gloucester in 1918	98,972	13,491	1,374,558	155,299	243,701	12,570	912,175	141,119	200	27	25,900	3,908
Landed at Portland in 1918	443,743	49,311	49,400	4,988	106,241	14,345			123,944	11,358		

QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., BY AMERICAN AND CANADIAN FISHING VESSELS DURING 1919, BY MONTHS—Continued.

Fishing grounds.	Miscellaneous.[1]				Total.				Grand total.	
	Fresh.		Salted.		Fresh.		Salted.			
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
LANDED AT BOSTON.										
January	486,283	$23,356			7,811,443	$492,372			7,811,443	$492,372
February	416,197	15,458			9,079,107	391,842			9,079,107	391,842
March	440,095	16,010	11,400	$285	14,123,021	484,621	11,400	$285	14,134,421	484,906
April	481,874	14,641			10,447,500	380,795			10,447,500	380,795
May	443,521	9,755			7,746,264	265,520			7,746,264	265,520
June	214,195	11,387			9,473,402	405,360	166,000	13,556	9,639,402	418,916
July	382,986	84,407			2,563,366	171,249			2,563,366	171,249
August	205,624	24,179			2,808,733	180,540	2,000	320	2,810,733	180,860
September	450,844	50,380			10,332,133	509,558	3,200	442	10,335,333	510,000
October	398,952	15,929			12,569,770	518,856			12,569,770	518,856
November	268,046	11,381			8,831,257	482,902			8,831,257	482,902
December	376,894	23,165			7,422,774	415,132			7,422,774	415,132
Total	4,565,511	300,048	11,400	285	103,208,770	4,698,747	182,600	14,603	103,391,370	4,713,350
LANDED AT GLOUCESTER.										
January	23,475	851	3,024,157	167,207	778,025	47,934	3,024,607	167,231	3,802,632	215,165
February	17,865	802			1,065,321	49,413	85	3	1,065,406	49,416
March					4,810,630	150,483	10,470	439	4,821,100	150,922
April	6,612	29			4,845,615	137,479	22,600	1,116	4,868,215	138,595
May	17,800	178			11,765,028	266,974	32,215	1,357	11,797,243	268,331
June					8,011,664	195,024	2,523,518	164,391	10,535,182	359,415
July	36,292	6,918			4,981,372	133,257	775,115	42,054	5,756,487	175,311
August					190,551	5,097	1,277,009	52,302	1,467,560	57,399
September					6,474,519	171,871	818,428	50,556	7,292,947	222,427
October					11,530,821	265,902	716,953	48,030	12,247,774	313,932
November					5,629,037	126,826	46,785	7,039	5,675,822	133,865
December	11,765	637	477,620	22,576	1,539,004	36,740	501,585	24,074	2,040,589	60,814
Total	113,809	9,415	3,501,777	189,783	61,621,587	1,587,000	9,749,370	558,592	71,370,957	2,145,592

LANDED AT PORTLAND.										
January	23,570	784			540,580	39,458			540,580	39,458
February	24,926	788			766,272	36,635			766,272	36,635
March	51,752	1,514			1,740,867	54,676			1,740,867	54,676
April	125,419	1,432			2,837,021	75,277			2,837,021	75,277
May	1,140,030	10,233			4,025,406	77,671			4,025,406	77,671
June	3,620,314	18,086			6,175,984	100,495	4,389	406	6,180,373	100,901
July	1,091,066	40,895			2,137,047	95,835			2,137,047	95,835
August	239,466	20,486			769,285	67,064			769,285	67,064
September	367,335	12,979			805,371	50,887	723	21	806,094	50,908
October	469,161	4,956			1,256,198	49,662	640	38	1,256,838	49,700
November	57,298	1,084			312,084	13,106			312,084	13,106
December	5,333	326			347,076	28,210			347,076	28,210
Total	7,215,670	113,563			21,713,191	688,976	5,752	465	21,718,943	689,441
Grand total	11,894,990	423,026	3,513,177	190,068	186,543,548	6,974,723	9,937,722	573,660	196,481,270	7,548,383
Grounds E. of 66° W. long.	187,776	26,727	3,501,777	189,783	45,695,309	1,653,348	9,799,111	561,413	55,494,420	2,214,761
Grounds W. of 66° W. long.	11,707,214	396,299	11,400	285	140,848,239	5,321,375	138,611	12,247	140,986,850	5,333,622
Landed at Boston in 1918	5,485,374	404,529			109,227,021	6,556,383	249,020	31,371	109,476,041	6,587,754
Landed at Gloucester in 1918	2,300,704	45,402	6,232,624	321,529	62,002,478	2,196,331	12,173,021	866,274	74,175,499	3,062,605
Landed at Portland in 1918	6,547,303	114,202			21,794,541	875,799	55,072	5,390	21,849,613	881,189

[1]Includes herring from Newfoundland, 3,501,777 pounds salted, value $189,783.

The fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by fishing vessels each year are taken principally from fishing grounds lying off the coast of the United States. In the calendar year 1919, 71.72 per cent of the quantity and 70.64 per cent of the value of the catch landed at these ports by American and Canadian fishing vessels were taken from these grounds; 2.93 per cent of the quantity and 4.61 per cent of the value, consisting largely of herring, from fishing banks off the coast of Newfoundland, and 25.33 per cent of the quantity and 24.74 per cent of the value from fishing grounds off the Canadian Provinces. Newfoundland herring constituted 1.78 per cent of the quantity and 2.51 per cent of the value of the fishery products landed at these ports during the year. The herring were taken on the treaty coast of Newfoundland, and the cod, haddock, hake, halibut, and other species from that region were obtained from fishing banks on the high seas. All fish caught by American fishing vessels off the coast of the Canadian Provinces were from offshore fishing grounds. The catch from each of these regions is given in detail in the following table:

QUANTITY AND VALUE OF FISH LANDED BY AMERICAN AND CANADIAN FISHING VESSELS AT BOSTON AND GLOUCESTER, MASS., AND PORTLAND, ME., IN 1919, FROM FISHING GROUNDS OFF THE COAST OF THE UNITED STATES, NEWFOUNDLAND, AND CANADIAN PROVINCES.

Species.	United States.		Newfoundland.		Canadian Provinces.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Cod:								
Fresh	34,117,400	$1,466,155	775,275	$26,634	25,758,486	$839,625	60,651,161	$2,332,414
Salted	22,433	1,252	864,291	50,839	3,836,535	198,676	4,723,259	250,767
Haddock:								
Fresh	69,210,257	2,430,043	144,725	2,442	13,206,041	355,213	82,561,023	2,787,698
Salted	450	16	5,764	209	148,948	6,015	155,162	6,240
Hake:								
Fresh	3,639,362	159,146	50,245	1,110	610,349	19,513	4,299,956	179,769
Salted	1,150	47	8,000	261	30,370	976	39,520	1,284
Pollock:								
Fresh	17,687,259	357,956	3,124	59	1,005,968	21,085	18,696,351	379,100
Salted	515	15	2,669	98	52,432	1,302	55,616	1,415
Cusk:								
Fresh	1,287,319	42,502	10,952	251	726,965	17,758	2,025,236	60,511
Salted			4,707	177	33,255	1,481	37,962	1,658
Halibut:								
Fresh	909,566	169,430	400,488	76,206	790,007	139,465	2,100,061	385,101
Salted	2,000	320	2,453	392	10,147	1,378	14,600	2,090
Mackerel:								
Fresh	2,237,342	298,516			2,077,428	128,588	4,314,770	427,104
Salted	100,663	10,312			1,297,763	109,826	1,398,426	120,138
Herring:								
Fresh	6,858,108	50,005					6,858,108	50,005
Salted			3,501,777	189,783			3,501,777	189,783
Swordfish: Fresh	777,320	188,716	315	110	105,092	23,542	882,727	212,368
Tilefish: Fresh	33,510	1,474					33,510	1,474
Miscellaneous:								
Fresh	4,038,276	156,104			82,369	3,075	4,120,645	159,179
Salted	11,400	285					11,400	285
Total	140,934,330	5,332,294	5,774,785	348,571	49,772,155	1,867,518	196,481,270	7,548,383

COD.—In 1919 the fishing fleet landing fish at Boston, Gloucester, and Portland was about the same size as in the previous year. There were 9 vessels in the salt-bank fishery and 111 in the market fishery landing their fares of cod and other ground fish at these ports during the year, while large quantities of cod were also landed by vessels fishing on the shore grounds. The total catch of cod landed at these ports during the year amounted to 65,374,420 pounds, valued at

$2,583,181, of which 4,723,259 pounds, valued at $250,767, were salted. Cod ranked second in importance among the various species landed.

Haddock.—The catch of haddock for the year ranked first in both quantity and value, being considerably larger than that of cod. The quantity of haddock landed at these ports by fishing vessels during the year amounted to 82,716,185 pounds, valued at $2,793,938, all of which was landed fresh except 155,162 pounds, valued at $6,240. The greater part of the catch was taken on Georges Bank and in South Channel.

Hake.—The catch of hake amounted to 4,339,476 pounds, valued at $181,053, all landed fresh except 39,520 pounds salted, valued at $1,284. There was a decline of 941,353 pounds, or 17.82 per cent, in the quantity and $92,032, or 33.70 per cent, in the value as compared with the previous year. The yield of this species has fallen off very much in the past few years. In 1916 over 13,000,000 pounds of hake were landed at these ports, and in 1910 the receipts at Boston and Gloucester were nearly 20,000,000 pounds.

Pollock.—The catch of pollock amounted to 18,751,967 pounds, valued at $380,515, all landed fresh except 55,616 pounds salted, valued at $1,415. There was a falling off in the catch of this species of 7,808,653 pounds in quantity and $581,570 in value as compared with the previous year.

Cusk.—The quantity of cusk landed was only 2,063,198 pounds, valued at $62,169, of which 37,962 pounds, valued at $1,658, were salted. The yield of this species was 595,062 pounds less in quantity and $40,862 less in value than in the previous year.

Halibut.—The catch of halibut amounted to 2,114,661 pounds, valued at $387,191, all landed fresh except 14,600 pounds salted, valued at $2,090. There was an increase in the catch of halibut of 333,657 pounds in quantity and $84,911 in value as compared with the previous year.

Mackerel.—The total catch of fresh mackerel taken by the American fishing fleet in 1919 was 53,992 barrels, compared with 69,314 barrels in 1918, a decrease of 15,322 barrels. The total catch of salted mackerel was 7,007 barrels, compared with 13,030 barrels the previous year, a decrease of 6,023 barrels. The quantity of mackerel landed at Boston, Gloucester, and Portland by the fishing fleet during the year was 5,713,196 pounds, valued at $547,242, of which 4,314,770 pounds, valued at $427,104, were fresh and 1,398,426 pounds, valued at $120,138, were salted. These were all landed by American fishing vessels.

Mackerel were reported schooling in southern waters the latter part of April, and prospects for mackerel fishing appeared to be good; but the mackerel seiners were delayed in sailing by a strike of the crews with regard to the pay of engineers. The first seiners arrived at New York with fares of mackerel April 25, one vessel landing 32,000 pounds and another 18,000 pounds. These fish weighed from 1½ to 3 pounds, although most of them did not exceed 2 pounds, and sold for 25 cents per pound. The southern mackerel fleet numbered 30 sail of seiners and 150 sail of netters. Both the seiners and the netters had a comparatively good season. The best stock made by a seiner was $13,232, the crew sharing $330 each. The mackerel landed by the southern fleet were mostly large and medium

fish, and sold from 8 to 18 cents per pound, according to market conditions.

The first fare of mackerel from the Cape Shore was landed on June 6, and amounted to 50,000 pounds of large and medium fish, which sold for 6.35 cents per pound. All of the Cape Shore fleet landed good trips of mackerel and stocked from $4,000 to $10,000 each. The fleet numbered 32 vessels compared with 38 the previous year. The total catch of mackerel from the Cape Shore was 2,119,000 pounds fresh, and 6,275 barrels salted, compared with 1,689,000 pounds fresh, and 7,558 barrels salted in 1918. The fresh mackerel sold from 5¼ to 7 cents per pound, the salted from $16 to $18.50 per barrel.

Tinker mackerel were present in small schools along the shore from Cape Ann to Chatham during the latter part of June.

The total catch of mackerel up to July 1 was 38,787 barrels fresh, and 6,452 barrels salted, compared with 29,259 barrels fresh and 8,079 barrels salted the previous year.

SWORDFISH.—The quantity of swordfish landed during the year was 882,447 pounds, valued at $212,302. The number of vessels engaged in this fishery was 56, or 19 more than in the previous year, but there was a considerable falling off in the catch.

FLOUNDERS.—The catch of flounders in the vessel fisheries amounted to 2,451,856 pounds, valued at $103,050, an increase of 182,049 pounds in quantity and $9,250 in value over the previous year. The catch taken by boats under 5 tons net tonnage is not included in these statistics.

HERRING.—The catch of herring amounted to 10,359,885 pounds, valued at $239,788. Of this quantity, 6,858,108 pounds, valued at $50,005, were taken off the coast of the United States and landed fresh, and 3,501,777 pounds, valued at $189,783, were salted Newfoundland herring.

VESSEL FISHERIES AT SEATTLE, WASH.

In the vessel fisheries at Seattle, Wash., there has been considerable decrease in both the quantity and value of products landed by the fishing fleet, but an increase in the products landed by collecting vessels as compared with the previous year. Statistics of the vessel fisheries at Seattle have been collected by the local agent and published as monthly and annual statistical bulletins, giving the quantity and value of fishery products landed by American fishing and collecting vessels at that port.

In 1919 the fishing fleet at Seattle landed 670 trips, aggregating 13,651,020 pounds of fish, having a value to the fishermen of $1,530,284. This catch was taken from the fishing grounds along the coast from Oregon to Albatross Bank, Alaska. The fishing areas from which the greater part of the products was obtained were Grays Harbor Grounds, Flattery Banks, West Coast of Vancouver Island, Hecate Strait, and Yakutat Grounds. The products included halibut, 11,110,720 pounds, valued at $1,422,519; sablefish, 1,553,600 pounds, valued at $74,290; "lingcod," 723,000 pounds, valued at $24,433; and rockfishes, 263,700 pounds, valued at $9,042. Compared with the previous year, there was a decrease of 164 trips by fishing vessels, and of 3,440,675 pounds, or 20.13 per cent, in quantity, and $357,369, or 18.93 per cent, in the value of the products landed. The catch of

halibut increased 866,520 pounds, or 8.46 per cent, in quantity, but decreased $106,327, or 6.95 per cent, in value. Sablefish decreased 2,801,350 pounds, or 64.32 per cent, in quantity, and $196,877, or 72.60 per cent, in value; "lingcod," 1,061,600 pounds, or 59.48 per cent, in quantity, and $37,859, or 60.77 per cent, in value; and rockfishes, 357,070 pounds, or 57.52 per cent, in quantity, and $13,857, or 60.51 per cent, in value. The falling off in the catch of these species may be attributed largely to a smaller demand than in the previous year.

The fishery products taken in Puget Sound and landed at Seattle by collecting vessels during the year amounted to 11,809,450 pounds, valued at $983,819. These products included salmon, 10,387,703 pounds, valued at $902,717; pilchard, 150,000 pounds, valued at $2,250; steelhead trout, 173,630 pounds, valued at $21,034; smelt, 296,041 pounds, valued at $14,723; rockfishes, 120,490 pounds, valued at $7,632; cod, 104,500 pounds, valued at $2,305; flounders, 99,940 pounds, valued at $2,613; sole, 104,200 pounds, valued at $3,972; crabs, 239,758 pounds, valued at $21,866; and other species amounting to 133,188 pounds, valued at $4,707. There was an increase in the products landed by collecting vessels over the previous year of 1,204,127 pounds, or 11.35 per cent, in quantity, and $71,221, or 7.80 per cent, in value. The quantity and value of fishery products landed at Seattle by fishing and collecting vessels in 1919 are given in detail in the following table:

Quantities and Values of Certain Fishery Products (Fresh) Landed at Seattle, Wash., by American Fishing Vessels, Calendar Year 1919.

	Number of trips.	Halibut.		Sablefish.	
		Pounds.	*Value.*	*Pounds.*	*Value.*
BY FISHING GROUNDS.					
Oregon coast	21	852,000	$93,446	41,000	$1,890
Columbia River grounds	6	275,000	31,493		
Grays Harbor grounds	48	813,300	110,444	337,000	16,255
Flattery Banks	292	1,951,700	268,624	482,200	21,829
West coast, Vancouver Island	108	1,075,200	152,679	200,900	9,537
Queen Charlotte Islands grounds	3	55,000	9,040		
Hecate Strait	157	4,040,500	514,116	391,800	19,547
Coronation Island	2	39,000	5,305		
Cape Ommaney	1	65,000	8,043		
Yakutat grounds	28	1,622,300	195,799	81,200	4,310
Portlock Bank	3	224,120	21,100	3,500	107
Albatross Bank	1	97,600	12,430	16,000	815
Total	670	11,110,720	1,422,519	1,553,600	74,290
BY MONTHS.					
January	7	124,900	22,000	31,500	2,450
February	14	97,800	16,532	7,000	350
March	41	360,300	51,995	51,000	2,631
April	70	871,000	112,300	14,000	745
May	102	977,200	113,648	42,000	1,530
June	120	2,186,200	257,938	16,000	640
July	99	2,033,220	219,707	64,000	3,117
August	72	1,511,800	187,900	385,500	19,475
September	51	860,400	126,994	633,000	30,185
October	54	647,400	125,216	220,400	8,957
November	14	283,000	49,959	46,700	2,280
December	26	1,157,500	138,330	42,500	1,930
Total	670	11,110,720	1,422,519	1,553,600	74,290

QUANTITIES AND VALUES OF CERTAIN FISHERY PRODUCTS (FRESH) LANDED AT SEATTLE, WASH., BY AMERICAN FISHING VESSELS, CALENDAR YEAR 1919—Contd.

	"Lingcod."		Rockfishes.		Total.	
BY FISHING GROUNDS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Oregon coast	14,000	$105	8,000	$205	915,000	$95,646
Columbia River grounds					275,000	31,493
Grays Harbor grounds	61,000	1,750	21,000	600	1,232,300	129,049
Flattery Banks	344,200	10,673	83,500	2,702	2,861,600	303,828
West coast, Vancouver Island	211,000	8,620	84,700	3,300	1,571,800	174,136
Queen Charlotte Islands grounds	15,000	900			70,000	9,940
Hecate Strait	68,000	2,165	64,500	2,155	4,564,800	537,983
Coronation Island	1,500	60			40,500	5,365
Cape Ommaney			2,000	80	67,000	8,123
Yakutat grounds	7,000	105			1,710,500	200,214
Portlock Bank					227,620	21,207
Albatross Bank	1,300	55			114,900	13,300
Total	723,000	24,433	263,700	9,042	13,651,020	1,530,284
BY MONTHS.						
January	15,500	1,225	9,000	810	180,900	26,485
February	97,000	5,155	22,200	1,250	224,000	23,287
March	76,000	2,355	36,000	1,180	523,300	58,161
April	146,700	3,934	86,000	2,332	1,117,700	119,311
May	155,500	2,619	39,500	680	1,214,200	118,477
June	50,000	2,060	9,000	360	2,261,200	260,998
July	21,000	875	1,000	40	2,119,220	223,739
August	42,000	1,550	29,000	1,080	1,968,300	210,005
September	46,800	1,875	14,000	560	1,554,200	159,614
October	22,000	980	10,000	430	899,800	135,583
November	10,000	400			339,700	52,639
December	40,500	1,405	8,000	320	1,248,500	141,985
Total	723,000	24,433	263,700	9,042	13,651,020	1,530,284

FISHERY PRODUCTS TAKEN IN PUGET SOUND AND LANDED AT SEATTLE, WASH., BY COLLECTING VESSELS DURING 1919, BY MONTHS.

Species.	January.		February.		March.		April.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Herring	12,000	$260			34,000	$340		
Pilchard	150,000	2,250						
Salmon:								
Chum or keta	140,000	13,800						
King or spring	8,000	1,200					31,500	$3,150
Miscellaneous	8,000	1,200					62,000	7,220
Trout: Steelhead	60,000	9,000	8,500	$1,275			6,200	620
Smelt	18,400	1,200						
Rockfishes	12,000	720	8,000	320	8,500	595	3,000	210
"Lingcod"					22,000	1,320	16,000	800
Cod			86,000	1,720	18,500	585		
Flounders	6,000	120	14,200	426	11,000	280	7,000	175
Sole	14,600	468	12,500	500	18,600	744	8,600	344
Crabs	30,800	2,100	24,000	1,680			39,710	2,918
Total	459,800	32,318	153,200	5,921	112,600	3,864	174,010	15,437

Fishery Products Taken in Puget Sound and Landed at Seattle, Wash., by Collecting Vessels During 1919, by Months—Continued.

Species.	May.		June.		July.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Sturgeon			1,480	$84	1,588	$75
Salmon:						
King or spring	312,800	$31,280	1,412,100	155,331	889,000	92,600
Coho or silver			83,910	8,390	21,480	2,960
Sockeye or red			42,780	4,705	5,500	585
Miscellaneous	63,660	6,366				
Trout: Steelhead	28,000	2,800	34,260	3,426	12,300	1,476
Rockfishes	8,000	560	4,250	136	7,600	532
"Lingcod"			4,600	92		
Flounders	8,870	176	12,420	248	4,520	90
Sole	2,200	88			1,500	60
Other fish					10,210	102
Crabs	13,612	928	10,340	1,240		
Total	437,142	42,198	1,606,140	173,652	953,698	98,480

Species.	August.		September.		October.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Sturgeon	2,850	$256	3,600	$216	3,600	$288
Salmon:						
Humpback or pink	592,400	35,544	516,800	31,008		
Chum or keta	485,948	24,297	457,040	27,420	662,389	33,119
King or spring	406,312	40,631	608,000	60,800	90,470	9,047
Coho or silver	163,880	9,932	1,233,600	123,360	244,424	24,424
Sockeye or red	34,930	3,493	6,300	63		
Trout: Steelhead	3,510	351			8,690	869
Smelt	116,461	5,823	135,080	6,400		
Perch					8,000	480
Rockfishes	6,000	420	14,300	1,001	12,840	898
"Lingcod"	2,130	42	7,000	210		
Flounders	9,530	336			4,000	80
Sole	11,600	464	4,000	160	12,000	480
Crabs					21,020	1,060
Total	1,835,551	121,589	2,985,720	250,638	1,067,433	70,745

Species.	November.		December.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Sturgeon					13,118	$919
Herring					46,000	600
Pilchard					150,000	2,250
Salmon:						
Humpback or pink					1,109,200	66,552
Chum or keta	957,750	$47,887	709,000	$88,625	3,412,127	235,148
King or spring	23,100	2,310	20,770	2,590	3,802,052	398,939
Coho or silver	93,860	9,380			1,841,154	178,446
Sockeye or red					89,510	8,846
Miscellaneous					133,660	14,786
Trout: Steelhead	12,170	1,217			173,630	21,034
Smelt	26,100	1,300			296,041	14,723
Perch					8,000	480
Rockfishes	20,000	1,400	16,000	840	120,490	7,632
"Lingcod"			4,130	142	55,860	2,606
Cod					104,500	2,305
Flounders	9,800	246	12,600	436	99,940	2,613
Sole			18,600	664	104,200	3,972
Other fish					10,210	102
Crabs	74,976	10,215	25,300	1,725	[1] 239,758	21,866
Total	1,217,756	73,955	806,400	95,022	11,809,450	983,819

[1] 11,005 dozen.

FISHERY PRODUCTS RECEIVED AT MUNICIPAL FISH WHARF AND MARKET, WASHINGTON, D. C.

Through the courtesy of the health department of the District of Columbia the Bureau has continued to receive daily reports of the quantity of fishery products received at the Municipal Fish Wharf and Market, Washington, D. C. These products, which are sold to the

retail markets of the city and also to some extent at retail at this market, it is estimated, represent about 60 per cent of the receipts for the city of Washington. In the following table, in which the statistics are given by months, it will be noted that the five most important products in terms of quantity are: Oysters, 2,146,107 pounds; squeteagues or "sea trout," 2,097,569 pounds; shad, 1,227,459 pounds; river herring, fresh and salted, 1,163,847 pounds; and croaker, 824,047 pounds; a total of 7,459,029 pounds, or 69.49 per cent of the entire receipts for the year, which amounted to 10,733,086 pounds. Such well-known forms as butterfish, carp, catfish, cod, croaker, eels, flounders, haddock, halibut, mullet, perch, pollock, squeteagues or "sea trout," striped bass, clams, oysters, and crabs, including crab meat, were received during each of the 12 months. March, April, and May were the months of the largest receipts; July and August, of the smallest.

FISHERY PRODUCTS RECEIVED AT MUNICIPAL FISH WHARF AND MARKET, WASHINGTON, D. C., IN 1919.

Species.	January.	February.	March.	April.	May.	June.	July.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Bass, black and sea	24,677	11,403	8,331	400	15,544	11,402	4,995
Bluefish	75			500	3,714	2,360	1,685
Bowfin	100						
Butterfish	16,912	3,375	8,990	4,775	39,750	49,860	73,395
Carp	8,986	6,743	8,984	19,354	21,903	6,645	4,464
Catfish	8,547	10,619	42,166	31,551	15,369	14,412	9,248
Cisco	500						
Cod	8,950	14,200	11,800	5,600	4,351	6,300	4,835
Crappie	5,007	800					
Crevalle	200						
Croaker	21,547	15,740	19,708	361,785	144,147	48,973	89,730
Drum, red		80					
Eels	83	553	3,355	2,569	1,878	500	446
Flounders	21,965	9,670	10,777	18,786	18,028	10,372	6,369
Gizzard shad	10,291	2,503		350	50	30	395
Haddock	19,700	24,275	23,150	11,950	10,350	9,400	8,585
Hake					100		
Halibut	2,168	10,857	3,850	4,800	3,625	3,125	5,775
Herring:							
River, fresh	31,133	79,278	281,011	491,501	116,389	285	
River, salted				6,750	98,750	28,750	
Hickory shad or "jacks"	2,335	5,487	4,076	2,184	169		
Kingfish				1,860	200		
Mackerel	88,000	48,100	5,300	7,000	14,846	57,160	7,116
Mullet	1,874	5,369	366	200	110	55	128
Perch	20,542	29,558	62,500	35,073	12,518	5,327	4,775
Pigfish					300		
Pike or pickerel	3,003	3,409	1,643	511			
Pollock	10,725	3,725	350	4,550	3,150	4,050	4,885
Salmon	450					187	150
Scup or porgy					225	500	600
Shad	14,509	38,422	254,349	751,846	149,423	6,232	
Sheepshead	600	860	200	200			
Smelt	3,175	875	125				
Snappers						328	
Spot	2,400	200		2,200	4,980	1,926	23,543
Squeteagues or "sea trout"	108,346	38,064	23,547	81,749	569,236	353,521	91,650
Striped bass	2,692	5,275	65,638	37,479	8,078	17,542	14,470
Sturgeon	66		50	400	307	162	
Tilefish	2,275	1,500	2,550	3,925	1,975	450	
Whitefish	200						
Whiting	43,093	66,389	30,569		600	4,200	16,000
Clams, hard	5,664	5,376	7,360	11,552	17,792	13,184	14,816
Oysters:							
In the shell	193,907	130,319	143,297	51,086	8,239	1,722	420
Opened	133,403	84,909	81,584	43,246	4,233		
Squid					100		
Crabs		75	180	6,015	21,450	48,935	94,500
Crab meat	3,925	4,205	6,175	9,400	16,545	20,555	15,820
Lobster						50	75
Shrimp	1,690	1,650	650	450	1,550	1,218	
Terrapin	240						
Turtles	560				4,361	786	150
Total	824,515	663,863	1,112,631	2,011,597	1,334,335	730,504	499,020

FISHERY PRODUCTS RECEIVED AT MUNICIPAL FISH WHARF AND MARKET, WASHINGTON, D. C., IN 1919—Continued.

Species.	August.	September.	October.	November.	December.	Total.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Bass, black and sea	356	914	10,905	14,355	27,328	130,610
Bluefish	8,634	8,310	12,350	3,500	2,600	43,728
Bowfin						100
Butterfish	50,525	31,664	23,000	6,900	350	309,496
Carp	4,814	8,497	11,496	9,073	5,974	116,933
Catfish	7,880	18,654	35,930	21,277	10,687	226,340
Cisco						500
Cod	1,000	3,025	8,400	10,400	10,220	89,081
Crappie						5,807
Crevalle						200
Croaker	40,157	13,700	42,700	24,510	1,350	824,047
Drum, red	400		1,200		300	1,980
Eels	208	805	3,029	1,629	556	15,611
Flounders	3,558	9,068	9,147	16,015	11,172	144,927
Gizzard shad	1,094	5,465	5,972	10,334	13,156	49,640
Haddock	4,025	17,725	12,350	11,800	13,600	166,910
Hake			1,600	36,400	14,300	52,400
Halibut	3,528	2,400	1,200	4,320	4,775	50,423
Herring:						
River, fresh						999,597
River, salted			30,000			164,250
Sea			[1] 400		42,400	42,800
Hickory shad or "jacks"						14,251
Kingfish		200		200		2,460
Mackerel	6,935	7,415	9,800	20,100	37,113	308,885
Mullet	287	858	1,233	4,769	953	16,202
Perch	4,512	3,184	7,714	16,451	12,560	214,714
Pigfish				1,600		1,900
Pike or pickerel	15	357	5,969	2,348	3,810	21,065
Pollock	1,010	2,800	5,600	16,400	18,000	75,245
Salmon	152		3,000	5,150	800	9,889
Scup or porgy	195	400				1,920
Shad	1,094	3,440	4,120	3,774	250	1,227,459
Sheepshead						1,860
Smelt					641	4,816
Snappers						328
Spot	5,392	28,377	37,300	6,200	600	113,118
Squeteagues or "sea trout"	195,446	243,108	239,287	104,700	48,915	2,097,569
Striped bass	7,984	25,833	37,788	28,676	12,056	263,511
Sturgeon	112					1,097
Tilefish			725	700	275	14,375
Tuna			460			460
Whitefish				400	200	800
Whiting	1,000	2,800	100	49,000	51,147	264,898
Clams, hard	11,904	7,328	9,888	6,656	6,496	118,016
Oysters:						
In the shell	700	34,293	168,945	280,518	170,772	[2] 1,184,218
Opened	2,568	34,716	121,789	235,245	220,196	[3] 961,889
Scallops			240	648	160	1,048
Squid						100
Crabs	47,640	20,985	4,170	75		244,025
Crab meat	12,595	1,190	6,660	8,035	4,555	109,660
Lobster			200		900	1,225
Shrimp	326		2,980	900	200	11,614
Terrapin						240
Turtles	237		1,835	100	820	8,849
Total	426,283	537,511	879,482	963,158	750,187	10,733,086

[1] Smoked.
[2] 169,174 bushels. The oysters have been reduced to pounds on the basis of 7 pounds of meat to a bushel, and 8¼ pounds to a gallon.
[3] 116,592 gallons.

SHAD FISHERY OF THE HUDSON RIVER.

The Bureau has collected the statistics of the shad fishery of the Hudson River without interruption for the five-year period 1915 to 1919, inclusive. In 1919 there were 299 men engaged in this fishery, using 158 boats valued at $6,700, 373 gill nets valued at $15,269, 12 seines valued at $1,700, and shore and accessory property valued at $7,920, a total investment of $31,589. The catch numbered 90,301 fish, or 374,974 pounds, valued at $83,724. Of this quantity

76,501 shad, or 301,306 pounds, valued at $60,690, were taken on the New York side of the river and 13,800 fish, or 73,668 pounds, valued at $23,034, on the New Jersey side.

From the table of comparative statistics it will be noted that this fishery reached its lowest level in 1916, not only in the size and value of the catch but in number of men engaged and boats and gear used. Compared with 1916 there was an increase in 1919 of 180 fishermen, or 151.26 per cent; of 88 boats, or 125.71 per cent; of 294 gill nets, or 372.15 per cent; of 9 haul seines, or 300 per cent; of 81,014 shad, or 872.33 per cent; and of $78,259 in the value of the product, or 1,432 per cent.

The principal apparatus of capture is the gill net. Of the total number of fish taken in 1915, 98 per cent were caught with gill nets; in 1916, 97 per cent; in 1917, 91 per cent; in 1918, 97 per cent; and in 1919, 98 per cent. The average number of fish taken per gill net for the various years follows: In 1915, 181; in 1916, 114; in 1917, 56; in 1918, 247; and 1919, 242. The value of the factor—that is, the average catch per gill net—as an index to the relative size of the runs of shad in the river is difficult to estimate. If this may be considered a reliable index, then the number of fish entering the river in 1917 was smaller than in 1916 and the runs for 1918 and 1919 were markedly larger than for the other years.

The results of the yearly canvasses are of considerable interest to those interested in the reestablishment of an extensive shad fishery in the Hudson River and in other rivers in which the supply has been seriously depleted as a source of possible light on the effects of protective measures which have been promulgated to afford better protection and to allow more fish to reach the spawning grounds.

SHAD FISHERY OF THE HUDSON RIVER, 1919.

Items.	New York.			New Jersey.			Total.		
	Number.	*Pounds.*	*Value.*	*Number.*	*Pounds.*	*Value.*	*Number.*	*Pounds.*	*Value.*
Fishermen	290			9			299		
Rowboats	154		$6,205	3		$375	157		$6,580
Gasoline	1		120				1		120
Gill nets	359		13,469	14		1,800	373		15,269
Seines	12		1,700				12		1,700
Shore and accessory property			3,920			4,000			7,920
Total			25,414			6,175			31,589
Shad caught:									
With gill nets	75,060	296,259	59,544	13,800	73,668	23,034	88,860	369,927	82,578
With seines	1,441	5,047	1,146				1,441	5,047	1,146
Total	76,501	301,306	60,690	13,800	73,668	23,034	90,301	374,974	83,724

COMPARATIVE STATISTICS OF SHAD FISHERY OF THE HUDSON RIVER, 1915 to 1919.

Year.	Personnel and investment.						Catch.		
	Fishermen.	Rowboats.	Gas boats.	Gill nets.	Haul seines.	Investment.	Number.	Pounds.	Value.
1915	160	88	4	86	2	$11,197	15,855	68,668	$8,643
1916	119	67	3	79	3	7,845	9,287	40,173	5,465
1917	149	74	2	215	13	14,595	12,015	43,384	6,540
1918	227	123	2	273	15	20,107	67,403	234,602	48,184
1919	299	157	1	373	12	31,589	90,301	374,974	83,724

SHAD AND ALEWIFE FISHERY OF THE POTOMAC RIVER.

The results of a yearly canvass of the shad fishery of the Hudson River where no shad-cultural operations are being practiced is given above. Believing that data of value might result from annual canvasses for a river on which extensive shad-cultural operations are being conducted, a canvass of the shad and alewife fisheries of the Potomac River for 1919 has been made, and it is planned to continue this canvass.

In 1919 there were 789 persons engaged in this fishery, using 514 boats valued at \$80,685; 306 pound nets valued at \$159,810; 267 gill nets and one haul seine, the latter being operated in Maryland, valued at \$26,761; and shore and accessory property valued at \$610; a total investment of \$267,866. The catch of shad numbered 544,469, or 2,040,473 pounds, valued at \$332,397. Of this quantity 94,512 shad, or 342,988 pounds, valued at \$56,833, were taken by Maryland fishermen, and 449,957 shad, or 1,697,485 pounds, valued at \$275,564, by Virginia fishermen. The catch of alewives numbered 8,867,902, or 3,676,921 pounds, valued at \$61,016. Of this quantity, 1,488,583 alewives, or 772,867 pounds, valued at \$15,508, were taken by Maryland fishermen and 7,379,319 alewives, or 2,904,054 pounds, valued at \$45,508, by Virginia fishermen.

As shown by the table of comparative statistics, the catch of shad in 1919 was much larger than in any of the years since 1901 for which statistical canvasses have been made. Compared with 1915, there was an increase of 198.5 per cent in the number of fish taken and 360.8 per cent in value. Whereas some years ago the river channel was in places practically closed by pound nets and the continued existence of a commercial fishery threatened through the inability of sufficient fish to reach the spawning ground, at present such nets may be set out from shore at a distance not greater than one-third the width of the river.

SHAD AND ALEWIFE FISHERY OF THE POTOMAC RIVER, 1919.

Items.	Maryland.			Virginia.			Total.		
	Number.	*Pounds.*	*Value.*	*Number.*	*Pounds.*	*Value.*	*Number.*	*Pounds.*	*Value.*
Fishermen	227			562			789		
Rowboats	82		\$3,300	220		\$6,972	302		\$10,272
Gasoline	33		7,255	179		63,158	212		70,413
Pound nets	101		12,400	205		147,410	306		159,810
Gill nets and seines [1]	65		9,253	203		17,508	268		26,761
Shore and accessory property			25			585			610
Total			32,233			235,633			267,866
Shad caught:									
With pound nets	8,941	36,061	5,498	251,986	951,954	166,694	260,927	988,015	172,192
With gill nets and seines [1]	85,571	306,927	51,335	197,971	745,531	108,870	283,542	1,052,458	160,205
Total	94,512	342,988	56,833	449,957	1,697,485	275,564	544,469	2,040,473	332,397
Alewives caught:									
With pound nets	1,258,083	691,500	13,158	6,486,719	2,606,520	34,550	7,744,802	3,298,020	47,708
With gill nets and seines [1]	230,500	81,367	2,350	892,600	297,534	10,958	1,123,100	378,901	13,308
Total	1,488,583	772,867	15,508	7,379,319	2,904,054	45,508	8,867,902	3,676,921	61,016

[1] Includes one haul seine, with the catch, operated in Maryland.

Comparative Statistics of Products of Shad and Alewife Fishery of the Potomac River for Various Years from 1896 to 1919.

Year.	Maryland.		Virginia.		Total.	
	Number.	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
Shad:						
1896	233,238	$20,524	450,825	$43,084	684,063	$63,608
1901	146,000	14,800	648,462	104,566	794,462	119,366
1904	83,147	16,343	289,500	51,709	372,647	68,052
1909	31,158	9,232	172,813	44,500	203,971	53,732
1915	17,196	6,827	165,206	65,300	182,402	72,127
1919	94,512	56,833	449,957	275,564	544,469	332,397
Alewives:						
1909	4,883,000	10,369	24,601,040	42,854	29,484,040	53,223
1915	335,000	1,420	7,276,428	30,741	7,611,428	32,161
1919	1,488,583	15,508	7,379,319	45,508	8,867,902	61,016

FISHERIES OF THE GREAT LAKES, LAKE OF THE WOODS, AND RAINY LAKE IN 1917.

The statistics of the fisheries of the Great Lakes, and Lake of the Woods, Rainy Lake, and Lakes Kabetogama and La Croix, Minn., presented in this report are for the calendar year 1917. The canvass of these fisheries was made by Winthrop A. Roberts and Rob Leon Greer, agents of this Bureau, and the statistics obtained have already been published in condensed form in Statistical Bulletin No. 436, and in "Fishery Industries of the United States. Report of the Division of Statistics and Methods of the Fisheries for 1918," Appendix X, Report, U. S. Commissioner of Fisheries, 1918, pages 42 to 47. The detailed statistics are published for the first time in the present report.

EARLIER PUBLICATIONS.

Earlier publications relating to the fisheries of the Great Lakes and published in Washington, D. C., are the following:

The Fisheries of the Great Lakes. Elaborated from notes gathered by Mr. Ludwig Kumlien, by Frederick W. True. The Fishery Industries of the United States, 1887, Section II, A Geographical Review of the Fisheries Industries and Fishing Communities for the year 1880, pp. 631–673.

The Fisheries of the Great Lakes, by Ludwig Kumlien. The Fishery Industries of the United States, 1887, Section V, vol. 1, pp. 755–769.

Report on an Investigation of the Fisheries of Lake Ontario, by Hugh M. Smith. Bulletin, U. S. Fish Commission, Vol. X, 1890, pp. 177–215.

Review of the Fisheries of the Great Lakes in 1885, compiled by Hugh M. Smith and Merwin-Marie Snell, with Introduction and Description of Fishing Vessels by J. W. Collins. Appendix, Report of Commissioner, U. S. Commission of Fish and Fisheries, 1887, pp. 1–333.

Report on the Fisheries of the Great Lakes, by Hugh M. Smith. Appendix, Report of Commissioner, U. S. Commission of Fish and Fisheries, 1892, pp. 361–462.

Report of the Division of Statistics and Methods of the Fisheries, by Hugh M. Smith. Report of Commissioner, U. S. Commission of Fish and Fisheries, 1895, pp. 93–103.

Report of the Joint Commission relative to the Preservation of the Fisheries in Waters Contiguous to Canada and the United States, by Richard Rathbun and William Wakeham. House Executive Document No. 315, Fifty-fourth Congress, second session, 1897, pp. 1–178.

Fisheries of Lake Ontario. Report of Commissioner, U. S. Commission of Fish and Fisheries, 1898, pp. CLII–CLVI.

Statistics of Certain Fisheries of the New England and Middle Atlantic States and the Great Lakes. Report, U. S. Fish Commission, 1898, pp. CLXVI–CLXXV. (In this report the figures presented relate to the fiscal year 1897.)

Statistics of the Fisheries of the Great Lakes. Appendix, Report of Commissioner, U. S. Commission of Fish and Fisheries, 1901, pp. 575–657.
Statistics of the Fisheries of the Great Lakes in 1903. Appendix, Report, U. S. Bureau of Fisheries, 1904, pp. 643–731.
Fisheries of the United States, 1908. Special Report, Bureau of the Census, 1911.

COMMON AND SCIENTIFIC NAMES OF FISHES OF THE GREAT LAKES.

For the sake of clarity as to the species referred to in the tables and discussions of the fisheries of the Great Lakes, the following list of common and scientific names of fishes is appended, the common name being the first given in every instance.

Bowfin	*Amiatus calvus.*
Burbot	*Lota maculosa.*
Carp, Asiatic	*Cyprinus carpio.*
Catfish	Ameirus (species). *Ictalurus punctatus.*
Ciscoes [1]	Leucichthys (species).[1]
Eel	*Anguilla chrysypa.*
Gold-eye	*Amphiodon alosoides.*
Muskellunge	*Esox masquinongy.*
Pike	*Esox lucius.* *Esox vermiculatus.*
Pike perch (blue pike)	*Stizostedion vitreum.*
Pike perch (wall-eyed or yellow pike)	*Stizostedion vitreum.*
Rock bass	*Ambloplites rupestris.*
Sauger	*Stizostedion canadense griseum.*
Sheepshead or drum	*Aplodinotus grunniens.*
Sturgeon	*Acipenser rubicundus.*
Suckers	Catostomidæ (species).
Sunfishes	Centrarchidæ (species).
Trout, lake	*Cristivomer namaycush.*
Trout, steelhead	*Salmo gairdneri.*
White bass	*Roccus chrysops.*
Whitefish, common	*Coregonus clupeiformis.* *Coregonus albus.*
Whitefish, menominee	*Coregonus quadrilateralis.*
Yellow perch	*Perca flavescens.*

GENERAL STATISTICS.

In presenting the detailed statistics of the fisheries of the Great Lakes it has been necessary to make some revisions of the preliminary statistics previously published, and the statistics of the fisheries of Lake of the Woods, Rainy Lake, and Lakes Kabetogama and La Croix are shown in separate tables.

The number of persons engaged in the fisheries of this entire region in 1917 was 9,416; the investment was $10,732,879; and the products amounted to 106,436,392 pounds, valued at $6,413,527.

In the fisheries of the Great Lakes in 1917 the number of persons engaged was 9,221, of whom 2,141 were on vessels fishing and transporting fishery products, 5,076 in the shore or boat fisheries, and 2,004 employed as shoresmen in the fisheries and wholesale fishery trade. In the fisheries of the various lakes the number of persons engaged was as follows: Superior, 1,348; Michigan, 3,313; Huron, 1,348; St. Clair and the St. Clair River, 64; Erie, 2,770; and Ontario, including the St. Lawrence and Niagara Rivers, 378. Compared with the returns for 1903, the year for which the last previous canvass was made by

[1] Includes lake herring, chub, longjaw, bluefin or blackfin, and tullibee.

the Bureau, there was an increase of 430 persons in Lake Superior, 72 in Lake Michigan, and 43 in Lake Erie, but a decrease of 356 in Lake Huron, 291 in Lake St. Clair and St. Clair River, and 10 in Lake Ontario, a total decrease of 112.

The investment in the fisheries and related industries amounted to $10,555,669, apportioned among the lakes as follows: Superior, $841,006; Michigan, $4,038,927; Huron, $1,188,705; St. Clair and St. Clair River, $15,955; Erie, $4,332,767; and Ontario, $138,309.

The investment included 585 steam and gasoline vessels engaged in fishing and transporting fishery products, of 7,844 net tons, valued at $1,512,983, with outfits valued at $372,106; 3,354 sail, row, and power boats valued at $536,763; fishing apparatus used on vessels and boats to the value of $2,630,388; shore and accessory property valued at $4,478,143; and cash capital amounting to $1,025,286. The apparatus of capture consisted principally of 8,333 pound nets and trap nets valued at $1,179,256 and 153,277 gill nets valued at $1,237,702. The investment, as compared with the returns for 1903, has increased in all the lakes except Lake St. Clair, the total increase being $3,081,247.

The products of the fisheries amounted to 104,269,223 pounds, having a value to the fishermen of $6,695,019. The yield of the various lakes was as follows: Superior, 15,547,432 pounds, valued at $726,674; Michigan, 35,460,628 pounds, valued at $2,270,859; Huron, 13,363,207 pounds, valued at $857,478; St. Clair and the St. Clair River, 133,330 pounds, valued at $11,852; Erie, 38,710,238 pounds, valued at $2,327,299; and Ontario and the St. Lawrence and Niagara Rivers, 1,054,388 pounds, valued at $100,857.

The principal species taken, including fresh, salted, and smoked fish, were carp, 7,563,347 pounds, valued at $331,938; ciscoes, which include lake herring, chub, longjaw, bluefin or blackfin, and tullibee, 53,529,325 pounds, valued at $2,609,917; pike perch, which include blue pike and wall-eyed or yellow pike, 4,599,524 pounds, valued at $438,299; sauger, 3,929,172 pounds, valued at $240,035; sheepshead or drum, 2,901,994 pounds, valued at $70,936; suckers, 5,362,428 pounds, valued at $204,881; lake trout, 13,344,139 pounds, valued at $1,286,704; whitefish, common, including caviar, 6,192,123 pounds, valued at $723,424; and yellow perch, 4,206,011 pounds, valued at $245,223. Various other species were also taken in considerable quantities. Compared with the returns for 1903, there has been an increase in the products of the fisheries of the Great Lakes of 18,074,406 pounds in quantity and of $3,549,518 in value. There has been considerable increase in both the quantity and value of the products in Lake Superior, Lake Michigan, Lake Huron, and Lake Erie, but a decrease in both quantity and value in Lake St. Clair, and a decrease in quantity with a large increase in value in Lake Ontario.

Compared with the returns for 1908, published by the Bureau of the Census, there was an increase of 8.06 per cent in the number of persons engaged, and of 119.27 per cent in the amount of capital invested, but there was a decrease of 2.21 per cent in the quantity, with an increase of 67.10 per cent in the value of the products. There was a large increase in the catch of burbot, cisco or lake herring, sheepshead or drum, and lake trout, but a decrease in carp, pike, pike perch, whitefish, and a number of other species. Compared with the statistics for 1903, published by the Bureau, there was a decrease of

1.20 per cent in the number of persons engaged, but an increase of 41.22 per cent in the amount of capital invested, and of 20.96 per cent in the quantity, and 129.28 per cent in the value of the products. There was considerable increase in nearly all of the more important species except pike perch, lake trout, and yellow perch. The increase in burbot, and possibly some of the other species, is, no doubt, due to the work of the Bureau in encouraging the more extensive use as food of species heretofore little used for that purpose.

The following tables present by lakes the number of persons engaged, the amount of capital invested, and the quantity and value of the products of the fisheries of the Great Lakes in 1917, and also comparative statistics of the extent of these fisheries in various years from 1880 to 1917:

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF THE GREAT LAKES IN 1917.

Items.	Lake Superior.		Lake Michigan.		Lake Huron.		Lake St. Clair.[1]	
PERSONS ENGAGED.	Number.	Value.	Number.	Value.	Number.	Value.	Number	Value.
On vessels fishing	166		1,096		149			
On vessels transporting	51		81		29			
Inshore fisheries	854		1,285		1,023		64	
Shoresmen	277		851		147			
Total	1,348		3,313		1,348		64	
INVESTMENT.								
Vessels fishing, steam	12	$52,800	92	$397,650	13	$57,500		
Tonnage	302		1,795		266			
Outfit		11,080		122,885		22,450		
Vessels, fishing, gasoline	4	20,500	240	234,310	13	19,000		
Tonnage	104		2,113		113			
Outfit		5,550		56,636		5,540		
Vessels, transporting, steam	4	56,000			2	7,000		
Tonnage	194				24			
Outfit		17,880				500		
Vessels, transporting, gasoline	7	19,500	60	38,225	19	33,500		
Tonnage	68		495		169			
Outfit		3,915		4,515		4,750		
Sail and row boats	417	10,220	428	9,943	310	8,020	60	$1,640
Power boats	280	82,405	311	91,595	260	103,960	4	900
Apparatus, vessel fisheries:								
Gill nets	1,806	31,995	57,453	535,616	6,613	69,575		
Lines		960		25,733		3,844		
Apparatus, shore fisheries:								
Pound nets and trap nets	204	26,262	1,134	242,570	1,731	207,904		
Gill nets	9,311	112,991	26,354	109,458	3,997	33,260		
Fyke nets			3,343	39,795	460	12,135		
Seines	5	325	61	18,120	77	7,960	6	1,365
Lines		4,813		2,135		2,095		50
Crawfish pots			6,400	1,600				
Other apparatus						1,520		
Shore and accessory property		341,310		1,758,341		432,092		12,000
Cash capital		42,500		349,800		156,100		
Total		841,006		4,038,927		1,188,705		15,955
PRODUCTS.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Bowfin	2,675	170			200	4		
Burbot			166,785	1,436	2,174	51		
Carp, Asiatic			246,503	7,500	1,145,250	43,474	85,330	4,652
Catfish and bullheads			164,466	6,627	33,329	3,295		
Ciscoes:								
Fresh	5,692,498	169,048	15,341,588	706,638	3,277,573	120,705		
Frozen	3,302,357	150,810						
Salted	3,258,227	139,959	2,917,766	139,344	2,100,792	94,957		
Smoked	5,400	432			3,000	120		
Muskellunge					145	15		
Pike	5,700	555	40,597	3,375	12,354	1,175		

[1] Includes St. Clair River.

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF THE GREAT LAKES IN 1917—Continued.

Items.	Lake Superior.		Lake Michigan.		Lake Huron.		Lake St. Clair.	
PRODUCTS—continued.								
Pike perch:								
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds*	*Value.*
Wall-eyed or yellow pike, fresh	27,979	$3,774	132,024	$18,445	994,642	$119,231	48,000	$7,200
Wall-eyed or yellow pike, salted					30	3		
Rock bass			1,714	137	4,283	208		
Sheepshead or drum			28,412	796	17,731	615		
Sturgeon			10,805	2,517	4,886	1,063		
Sturgeon caviar			346	904	227	495		
Suckers:								
Fresh	326,203	13,184	2,104,453	74,859	1,775,767	72,883		
Salted	15,850	560	14,110	625	1,000	50		
Sunfishes					1,650	68		
Trout, lake:								
Fresh	2,537,081	209,597	8,647,895	852,879	2,070,797	213,790		
Frozen	44,000	5,800						
Salted	7,272	576	2,820	259	8,658	784		
Trout, steelhead			21,950	3,349				
White bass			1,275	77				
Whitefish:								
Common, fresh	302,210	30,943	3,045,448	323,162	993,501	124,050		
Common, salted			1,945	201	3,350	330		
Common, caviar					1,375	257		
Menominee, fresh	12,080	682	100,332	4,829	46,457	2,191		
Menominee, salted	2,900	228	26,103	1,973	20,017	1,200		
Yellow perch:								
Fresh	5,000	356	2,361,071	116,419	844,019	56,464		
Salted			1,725	81				
Crawfish			80,495	4,427				
Total	15,547,432	726,674	35,460,628	2,270,859	13,363,207	857,478	133,330	11,852

Items.	Lake Erie.[1]		Lake Ontario.[2]		Total.	
PERSONS ENGAGED.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
On vessels fishing	517		2		1,930	
On vessels transporting	48		2		211	
Inshore fisheries	1,487		363		5,076	
Shoresmen	718		11		2,004	
Total	2,770		378		9,221	
INVESTMENT.						
Vessels, fishing, steam	73	$469,398			190	$977,348
Tonnage	1,700				4,063	
Outfit		93,679				249,494
Vessels, fishing, gasoline	20	39,000	1	$1,200	278	314,010
Tonnage	183		8		2,521	
Outfit		7,986		20		76,332
Vessels, transporting, steam	5	24,500			11	87,500
Tonnage	111				329	
Outfit		5,200				23,580
Vessels, transporting, gasoline	19	41,600	1	1,300	106	134,125
Tonnage	193		10		935	
Outfit		9,455		65		22,700
Sail and row boats	602	27,370	189	4,765	2,006	61,958
Power boats	414	178,815	79	17,130	1,348	474,805
Apparatus, vessel fisheries:						
Gill nets	38,007	272,577	3	40	103,882	909,803
Lines						30,537
Apparatus, shore fisheries:						
Pound nets and trap nets	5,011	681,060	353	21,460	8,433	1,179,256
Gill nets	9,571	57,055	162	15,135	49,395	327,899
Fyke nets	801	44,403	334	4,374	4,938	100,707
Seines	285	38,867	12	610	446	67,247
Lines		741		1,174		11,008
Crawfish pots					6,400	1,600
Fishing machines			7	795	7	795
Other apparatus		10		6		1,536
Shore and accessory property		1,884,165		50,235		4,478,143
Cash capital		456,886		20,000		1,025,286
Total		4,332,767		138,309		10,555,669

[1] Includes men and investment in the wholesale fish trade of Detroit.
[2] Includes St. Lawrence and Niagara Rivers.

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF THE GREAT LAKES IN 1917—Continued.

Items.	Lake Erie.		Lake Ontario.		Total.	
PRODUCTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Bowfin	5,165	$69	7,046	$350	15,086	$593
Burbot	652,870	8,027	61,760	2,388	883,589	11,902
Carp, Asiatic	6,044,792	274,139	41,472	2,173	7,563,347	331,938
Catfish and bullheads	628,532	39,232	47,934	5,935	874,261	55,089
Ciscoes:						
Fresh	17,160,852	1,046,862	460,363	39,991	41,932,874	2,083,244
Frozen					3,302,357	150,810
Salted			8,909	1,051	8,285,694	375,311
Smoked					8,400	552
Eel			43,007	3,402	43,007	3,402
Gold-eye	10,335	104			10,335	104
Muskellunge					145	15
Pike	5,666	550	16,191	2,149	80,508	7,804
Pike perch:						
Blue pike	2,057,073	135,241	45,730	4,784	2,102,803	140,025
Wall-eyed or yellow pike, fresh	1,291,456	149,163	2,590	458	2,496,691	298,271
Wall-eyed or yellow pike, salted					30	3
Rock bass	100	5	7,525	463	13,622	813
Sauger	3,929,172	240,035			3,929,172	240,035
Sheepshead or drum	2,855,551	69,502	300	23	2,901,994	70,93
Sturgeon	28,384	6,064	51,141	12,057	95,216	21,701
Sturgeon, caviar	1,018	2,045	544	1,232	2,135	4,676
Suckers:						
Fresh	1,035,934	36,403	89,111	6,317	5,331,468	203,646
Salted					30,960	1,235
Sunfishes			23,885	1,327	25,535	1,395
Trout, lake:						
Fresh	1,922	201	23,694	2,818	13,281,389	1,279,285
Frozen					44,000	5,800
Salted					18,750	1,619
Trout, steelhead					21,950	3,349
White bass	286,112	17,212			287,387	17,289
Whitefish:						
Common, fresh	1,755,947	232,761	88,347	11,720	6,185,453	722,636
Common, salted					5,295	531
Common, caviar					1,375	257
Menominee, fresh					158,869	7,702
Menominee, salted					49,020	3,401
Yellow perch:						
Fresh	959,357	69,684	34,839	2,219	4,204,286	245,142
Salted					1,725	81
Crawfish					80,495	4,427
Total	38,710,238	2,327,299	1,054,388	100,857	104,269,223	6,295,019

COMPARATIVE STATISTICS OF THE FISHERIES OF THE GREAT LAKES FOR VARIOUS YEARS FROM 1880 TO 1917.

PERSONS ENGAGED.

Lake.	1880	1885	1890	1893	1899	1903	1908	1917
Superior	414	914	653	916	613	918	792	1,348
Michigan	1,578	3,379	2,877	3,928	3,255	3,241	2,706	3,313
Huron	470	892	726	944	1,241	1,704	1,382	1,348
St. Clair [1]	356	272	611	529	442	355	221	64
Erie [2]	1,620	4,298	4,482	3,622	3,728	2,727	3,142	2,770
Ontario [3]	612	600	389	241	391	388	296	378
Total	5,050	10,355	9,738	10,180	9,670	9,333	8,539	9,221

[1] Includes St. Clair and Detroit Rivers. There was no fishing in Detroit River in 1917.
[2] Includes persons in wholesale trade of Detroit, Mich.
[3] Includes St. Lawrence and Niagara Rivers.

COMPARATIVE STATISTICS OF THE FISHERIES OF THE GREAT LAKES FOR VARIOUS YEARS FROM 1880 TO 1917—Continued.

APPARATUS AND CAPITAL EMPLOYED.

Lake and year.	Vessels and boats.[1]		Pound nets and trap nets.		Gill nets.		Seines.		Value of other apparatus.[2]	Shore property and cash capital.	Total.
	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.	Value.	Value.	Value.
Superior:											
1880	161	$26,240	43	$14,950	4,630	$25,280	32	$2,010	$200	$12,700	$81,380
1885	519	100,735	230	67,520	7,557	78,082	43	2,920	1,155	177,521	427,933
1890	328	85,275	140	34,435	5,974	63,476	19	955	2,763	179,778	366,682
1893	447	139,035	276	63,415	8,899	87,680	14	500	1,565	209,512	529,024
1899	315	69,045	162	25,820	7,229	99,283	1	50	1,058	167,023	372,083
1903	378	141,109	218	27,793	10,169	127,238	8	335	815	299,032	596,322
1908	......	149,000	......	....	......	....	......	......	159,000	83,000	391,000
1917	724	241,425	204	26,262	11,117	144,986	5	325	5,773	383,810	802,581
Michigan:											
1880	836	133,375	476	185,425	24,599	124,740	19	2,040	1,455	104,100	551,135
1885	1,402	368,326	715	253,840	58,516	326,902	87	6,950	13,457	788,356	1,757,831
1890	1,102	266,331	844	244,880	40,896	215,914	30	3,480	13,460	693,159	1,437,224
1893	1,549	357,987	785	181,385	54,232	352,084	28	2,520	27,863	1,092,219	2,063,497
1899	1,178	281,968	805	186,349	49,857	288,395	11	510	29,285	2,087,829	2,915,241
1903	1,363	386,396	980	198,960	48,645	269,754	44	2,384	37,743	2,593,950	3,489,187
1908	......	692,000	......	....	......	....	......	......	753,000	519,000	1,964,000
1917	1,131	771,723	1,134	242,570	83,807	645,074	61	18,120	69,263	2,108,141	3,854,891
Huron:											
1880	111	20,905	189	49,425	3,360	20,600	28	5,600	3,500	3,700	103,730
1885	561	72,946	586	113,350	3,444	35,333	......	......	23,100	140,620	385,349
1890	417	36,898	551	88,515	2,206	21,665	6	600	7,155	254,025	408,858
1893	520	87,645	731	108,508	4,923	53,071	1	75	3,807	236,285	503,700
1899	539	87,585	996	111,839	5,676	54,384	9	673	8,188	203,989	474,953
1903	643	126,418	1,685	176,495	6,129	51,526	18	608	13,977	482,615	851,639
1908	......	185,000	......	....	......	....	......	......	281,000	267,000	733,000
1917	617	228,980	1,731	207,904	10,610	102,835	77	7,960	19,594	588,192	1,155,465
St. Clair:[3]											
1880	52	8,000	......	....	180	1,080	42	6,000	1,500	24,000	40,580
1885	215	7,457	57	12,550	23	160	34	8,825	3,819	218,270	251,081
1890	166	28,775	34	9,450	814	9,418	28	6,240	5,580	150,682	210,145
1893	211	13,728	91	7,400	380	4,260	20	3,025	2,346	206,672	240,076
1899	188	3,770	5	1,050	60	600	13	1,255	915	46,945	54,535
1903	150	3,150	......	....	......	....	6	890	961	234,884	239,885
1908	......	10,000	......	....	......	....	......	......	8,000	28,000	46,000
1917	64	2,540	......	....	......	....	6	1,365	50	12,000	15,955
Erie:											
1880	602	83,880	758	233,600	5,775	22,500	18	2,800	8,645	163,675	515,100
1885	1,536	298,757	1,028	259,785	22,644	75,507	71	8,320	72,205	847,564	1,562,138
1890	1,449	520,033	1,893	548,100	49,320	169,513	44	5,305	70,601	1,502,750	2,816,302
1893	1,146	424,227	1,783	439,060	35,369	164,683	47	4,440	23,339	1,423,017	2,506,842
1899	980	435,566	1,724	329,500	41,678	229,182	104	8,390	19,362	1,614,677	2,720,554
1903	608	490,236	1,469	172,805	35,150	180,581	110	8,040	18,350	1,326,385	2,196,397
1908	......	603,000	......	....	......	....	......	......	615,000	426,000	1,644,000
1917	1,133	780,683	5,011	681,060	47,578	329,632	285	38,867	45,154	2,341,051	4,216,447
Ontario:[4]											
1880	167	13,100	34	14,000	6,000	20,000	9	1,950	....	5,000	54,050
1885	467	20,448	350	19,445	4,722	23,952	69	3,177	12,627	56,100	135,749
1890	376	31,162	288	24,577	2,345	18,110	27	656	10,361	38,667	123,533
1893	177	9,619	77	2,310	1,185	8,794	7	175	2,240	32,250	56,131
1899	289	9,482	145	5,850	1,187	18,674	24	420	7,194	38,640	80,350
1903	234	15,457	176	9,945	1,796	13,862	8	205	9,303	52,220	100,992
1908	......	11,000	......	....	......	....	......	......	16,000	7,900	34,900
1917	270	24,395	353	21,460	165	15,175	12	610	6,349	70,235	138,224
All lakes:											
1880	1,929	285,500	1,500	497,400	44,544	214,200	148	20,400	15,300	313,175	1,345,975
1885	4,700	868,669	2,966	726,490	96,906	539,936	304	30,192	126,363	2,228,431	4,520,081
1890	3,838	968,474	3,750	949,957	101,555	498,096	154	17,236	109,920	2,819,061	5,362,774
1893	4,050	1,032,241	3,743	802,078	104,988	670,572	117	10,735	61,160	3,199,955	5,899,270
1899	3,489	887,416	3,837	660,408	105,687	690,518	162	11,298	66,002	4,159,103	6,617,716
1903	3,376	1,162,766	4,528	585,998	101,889	642,961	194	12,462	81,149	4,989,086	7,474,422
1908	......	1,651,000	......	....	......	....	......	......	1,831,000	1,332,000	4,814,000
1917	3,939	2,049,746	8,433	1,179,256	153,277	1,237,702	446	67,247	115,586	5,503,429	10,183,563

[1] In 1908 the outfit of the vessels is included in the value.
[2] Includes all forms of apparatus in 1908.
[3] Includes St. Clair and Detroit Rivers. There was no fishing in Detroit River in 1917.
[4] Inclues St. Lawrence and Niagara Rivers.

Comparative Statistics of the Fisheries of the Great Lakes for Various Years from 1880 to 1917—Continued.

PRODUCTS.[1]

Lake and year.	Whitefish.	Trout.	Ciscoes.	Sturgeon.	All other.	Total.	
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Value.*
Superior:							
1880	2,257,000	1,464,750	34,000	....	60,875	3,816,625	$118,370
1885	4,571,947	3,488,177	324,680	182,760	258,416	8,825,980	291,523
1890	3,213,176	2,613,378	199,121	47,482	42,835	6,115,992	220,968
1893	2,732,270	4,342,122	660,272	62,052	300,211	8,096,927	252,107
1899	693,191	3,118,169	1,125,478	4,415	488,401	5,429,654	150,862
1903	794,022	4,954,830	4,742,805	13,137	2,700,219	13,205,013	343,671
1908	910,100	2,752,200	5,587,600	67,600	878,000	10,195,500	342,000
1917	302,210	2,588,353	12,258,482	....	398,387	15,547,432	726,674
Michigan:							
1880	12,030,400	2,659,450	3,050,400	3,839,600	1,562,025	23,141,875	668,400
1885	8,682,986	6,431,298	3,312,493	1,406,678	3,684,693	23,518,148	878,788
1890	5,455,079	8,364,167	6,082,082	946,897	5,586,041	26,434,266	830,465
1893	2,330,060	8,216,920	11,580,895	311,780	8,308,100	30,747,755	828,611
1899	1,510,364	5,488,947	21,573,716	108,279	5,818,690	34,499,996	876,743
1903	1,972,594	9,049,299	13,863,617	56,420	8,637,568	33,579,498	1,090,550
1908	2,490,900	7,892,000	21,842,000	70,500	7,521,900	39,817,300	1,554,000
1917	3,047,393	8,650,715	18,259,354	10,805	5,492,361	35,460,628	2,270,859
Huron:							
1880	2,700,778	2,084,500	246,800	204,000	1,969,195	7,205,273	195,277
1885	1,425,380	2,539,780	1,265,650	215,500	6,010,860	11,457,170	276,397
1890	1,004,094	1,505,619	2,514,551	365,718	4,666,399	10,056,381	221,067
1893	1,178,271	3,439,575	2,758,628	79,553	4,608,311	12,064,338	306,381
1899	592,308	1,887,101	3,699,807	30,497	6,208,614	12,418,327	308,078
1903	692,863	2,108,632	4,640,967	34,343	6,978,404	14,455,209	450,318
1908	719,000	1,358,800	4,791,000	9,900	6,053,300	12,932,000	486,000
1917	996,851	2,079,455	5,381,365	4,886	4,900,650	13,363,207	857,478
St. Clair:[2]							
1880	77,922	....	250,700	998,500	523,805	1,850,927	36,273
1885	41,125	....	1,208,150	227,780	708,740	2,185,795	40,193
1890	238,764	244,847	490,334	309,003	1,711,623	2,994,571	73,577
1893	50,950	72,000	140,112	54,106	1,497,143	1,814,311	46,030
1899	69,902	69,915	....	7,600	431,650	579,067	23,864
1903	25,591	....	....	8,800	487,550	521,941	21,594
1908	....	....	....	13,000	724,700	737,700	32,000
1917	....	....	....	....	133,330	133,330	11,852
Erie:							
1880	3,333,800	26,200	11,774,400	1,970,000	11,982,900	29,087,300	474,880
1885	3,531,855	106,900	19,354,900	4,727,950	23,734,912	51,456,517	1,109,096
1890	2,341,451	121,420	38,868,283	2,078,907	21,440,812	64,850,873	1,000,905
1893	1,292,410	203,132	20,931,076	793,800	19,747,907	42,968,325	805,979
1899	2,066,314	32,024	33,427,797	789,402	22,078,327	58,393,864	1,150,895
1903	302,805	15,127	8,788,625	300,103	13,781,896	23,188,556	780,015
1908	1,503,000	6,900	10,599,100	63,900	29,733,600	41,906,500	1,280,000
1917	1,755,947	1,922	17,160,852	28,384	19,763,133	38,710,238	2,327,299
Ontario:[3]							
1880	1,064,000	569,700	611,217	545,283	849,800	3,640,000	159,700
1885	90,711	20,510	403,585	386,974	1,496,686	2,398,466	95,869
1890	148,771	41,010	598,978	541,752	2,115,937	3,446,448	124,786
1893	45,380	6,204	164,998	125,293	586,140	928,015	31,510
1899	161,935	15,432	86,778	189,155	1,953,032	2,406,332	100,997
1903	25,384	4,050	121,315	226,095	867,756	1,244,600	59,353
1908	56,000	14,000	35,000	37,000	679,800	821,800	74,000
1917	88,347	23,694	469,272	51,141	421,934	1,054,388	100,857
All lakes:							
1880	21,463,900	6,804,600	15,967,517	7,557,383	16,948,600	68,742,000	1,652,900
1885	18,344,004	12,586,665	25,869,458	7,147,642	35,894,307	99,842,076	2,691,866
1890	12,401,335	12,890,441	48,753,349	4,289,759	35,563,647	113,898,531	2,471,768
1893	7,629,341	16,279,953	36,235,981	1,426,584	35,047,812	96,619,671	2,270,618
1899	5,094,014	10,611,588	59,913,576	1,129,348	36,978,714	113,727,240	2,611,439
1903	3,813,259	16,131,938	32,157,319	638,898	33,453,393	86,194,817	2,745,501
1908	5,679,000	12,023,900	42,854,700	261,900	45,591,300	106,410,800	3,768,000
1917	6,190,748	13,344,139	53,529,325	95,216	31,109,795	104,269,223	6,295,019

[1] In this table caviar and other secondary products are omitted except in 1893, 1899, and 1903. In 1880, 1885, and 1890 bluefin, longjaw, and menominee in Lake Michigan and menominee in Lake Huron are included with whitefish. In 1893 and 1899 bluefin in Lake Superior, bluefin and menominee in Lake Michigan, and menominee in Lake Huron are included with "all other," and longjaw in Lake Michigan with ciscoes. In 1903, bluefin, menominee, longjaw, and steelhead trout are included with "all other." In 1908 and 1917 ciscoes (herring) include longjaw, bluefin or blackfin, and tullibee.

The statistics for 1908 in these tables are from data published by the Bureau of the Census.

[2] Includes St. Clair and Detroit Rivers. There was no fishing in Detroit River in 1917.

[3] Includes St. Lawrence and Niagara Rivers.

FISHERIES OF LAKE SUPERIOR.

The number of persons engaged in the fisheries of Lake Superior in 1917 was 1,348, of whom 166 were on fishing vessels, 51 on vessels transporting fishery products, 854 in the shore or boat fisheries, and 277 in the wholesale fishery trade and other occupations on shore connected with the fishery industries.

The investment amounted to $841,006. This included 16 steam and gasoline fishing vessels, valued at $73,300, with a net tonnage of 406 tons and outfits valued at $16,630; 11 steam and gasoline transporting vessels, valued at $75,500, with a net tonnage of 262 tons and outfits valued at $21,795; 697 power, sail, and row boats, valued at $92,625; fishing apparatus employed on vessels to a value of $32,955; fishing apparatus employed on boats to a value of $144,391; shore and accessory property valued at $341,310 and cash capital amounting to $42,500.

The principal forms of fishing apparatus were gill nets, pound nets, and trap nets. The number of gill nets used on vessels was 1,806, valued at $31,995; and on boats 9,311, valued at $112,991; a total in both fisheries of 11,117 nets, representing a value of $144,986. The number of pound nets and trap nets in operation was 204, valued at $26,262,

The products of the fisheries of Lake Superior amounted to 15,547,432 pounds ,valued at $726,674. Among the species of special importance were the following: Ciscoes, 12,258,482 pounds, valued at $460,249, representing 78.85 per cent of total quantity of fish and 63.34 per cent of total value of fish taken in the lake; lake trout, 2,588,353 pounds, valued at $215,973; suckers, 342,053 pounds, valued at $13,744; and common whitefish, 302,210 pounds, valued at $30,943.

Compared with the other lakes, Lake Superior ranked third in quantity of products and fourth in value of products, number of persons engaged, and amount of invested capital. Compared with 1903 there was an increase of 430, or 46.84 per cent, in the number of persons employed; $244,684, or 41.03 per cent, in the amount of capital invested; and 2,342,419 pounds, or 17.74 per cent, in quantity, and $383,003 or 111.44 per cent, in the value of the products.

FISHERIES, BY STATES AND COUNTIES.

The following tables show by States and counties the number of persons employed, investment, and quantity and value of the products of the fisheries in 1917:

STATISTICS OF THE FISHERIES OF LAKE SUPERIOR IN 1917, BY STATES AND COUNTIES.

PERSONS ENGAGED.

State and county.	On vessels fishing.	On vessels transporting.	In shore fisheries.	Shoresmen.	Total.
Michigan:					
Alger			44	2	46
Baraga			30		30
Chippewa	20		43	15	78
Gogebic			10		10
Houghton			78		78
Keweenaw		3	53		56
Marquette	22		16	15	53
Ontonagon			17		17
Total	42	3	291	32	368
Wisconsin:					
Ashland			6	7	13
Bayfield	74		117	154	345
Douglas			9	3	12
Iron			2		2
Total	74		134	164	372
Minnesota:					
Cook			185		185
Lake		4	168		172
St. Louis	50	44	76	81	251
Total	50	48	429	81	608
Grand total	166	51	854	277	1,348

INVESTMENT.

State and county.	Vessels, fishing.								Vessels, transporting.			
	Steam.				Gasoline.				Steam.			
	Number.	Tonnage.	Value.	Value of outfit.	Number.	Tonnage.	Value.	Value of outfit.	Number.	Tonnage.	Value.	Value of outfit.
Michigan:												
Chippewa	1	48	$5,000	$2,600	1	66	$5,000	$2,600				
Marquette	2	78	6,500	5,200								
Total	3	126	11,500	7,800	1	66	5,000	2,600				
Wisconsin:												
Bayfield	4	96	29,800	1,520	1	12	7,000	225				
Minnesota:												
St. Louis	5	80	11,500	1,760	2	26	8,500	2,725	4	194	$56,000	$17,880
Grand total	12	302	52,800	11,080	4	104	20,500	5,550	4	194	56,000	17,880

STATISTICS OF THE FISHERIES OF LAKE SUPERIOR IN 1917, BY STATES AND COUNTIES—Continued.

INVESTMENT—Continued.

State and county.	Vessels transporting—Contd. Gasoline.				Sail and row boats.		Power boats.		Apparatus of capture, vessel fisheries. Gill nets.		
	Number.	Tonnage.	Value.	Value of outfit.	Number.	Value.	Number.	Value.	Number.	Value.	Value of lines.
Michigan:											
Alger					9	$190	18	$8,625			
Baraga					17	290	8	1,850			
Chippewa					16	220	13	5,700	214	$7,470	$560
Gogebic					2	45	4	1,200			
Houghton					15	185	33	11,400			
Keweenaw	1	10	$2,000	$500	12	265	20	6,000			
Marquette					1	15	8	3,820	920	11,800	
Ontonagon					2	20	5	2,200			
Total	1	10	2,000	500	74	1,230	109	40,795	1,134	19,270	560
Wisconsin:											
Ashland					2	35	3	675			
Bayfield					66	1,110	45	21,075	450	7,550	400
Douglas					5	75	2	800			
Iron							2	600			
Total					73	1,220	52	23,150	450	7,550	400
Minnesota:											
Cook					142	4,250	57	5,760			
Lake	1	8	4,000	500	81	2,270	32	6,975			
St. Louis	5	50	13,500	2,915	47	1,250	30	5,725	222	5,175	
Total	6	58	17,500	3,415	270	7,770	119	18,460	222	5,175	
Grand total	7	68	19,500	3,915	417	10,220	280	82,405	1,806	31,995	960

State and county.	Apparatus of capture, shore fisheries. Pound nets and trap nets.		Gill nets.		Seines.		Value of lines.	Shore and accessory property.	Cash capital.	Total investment.
	Number.	Value.	Number.	Value.	Number.	Value.				
Michigan:										
Alger	34	$4,912	446	$4,205	3	$240	$623	$10,725		$29,520
Baraga	22	2,010	124	875				1,010		6,035
Chippewa	80	7,490	546	5,375			325	45,425	$5,000	92,765
Gogebic			83	539				1,185		2,969
Houghton	2	325	1,000	6,639	2	85	560	20,780		39,974
Keweenaw	8	1,825	840	8,635			30	18,525		37,780
Marquette	1	300	216	2,400			6	12,200		42,241
Ontonagon	4	450	175	1,650			575	2,200		7,095
Total	151	17,312	3,430	30,318	5	325	2,119	112,050	5,000	258,379
Wisconsin:										
Ashland	4	450	65	750			140	7,375	5,000	14,425
Bayfield	44	8,000	845	11,285			1,229	38,275	9,000	136,469
Douglas			44	650				390	500	2,415
Iron			12	175				100		875
Total	48	8,450	966	12,860			1,369	46,140	14,500	154,184
Minnesota:										
Cook			2,387	35,503			100	17,870		63,483
Lake			1,536	21,865			125	11,900		47,635
St. Louis	5	500	992	12,445			1,100	153,350	23,000	317,325
Total	5	500	4,915	69,813			1,325	183,120	23,000	428,443
Grand total	204	26,262	9,311	112,991	5	325	4,813	341,310	42,500	841,006

STATISTICS OF THE FISHERIES OF LAKE SUPERIOR IN 1917, BY STATES AND COUNTIES—Continued.

YIELD, BY SPECIES.

State and county.	Bowfin.		Ciscoes. Fresh.		Ciscoes. Frozen.		Ciscoes. Salted.		Ciscoes. Smoked.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Michigan:										
Alger			4,100	$195			500	$23		
Baraga			95,200	4,030						
Chippewa			185,062	8,425						
Gogebic			17,060	680						
Houghton			179,600	7,966						
Keweenaw	2,675	$170	73,825	3,484						
Marquette			325,109	12,835						
Ontonagon			44,000	1,556						
Total	2,675	170	923,986	39,171			500	23		
Wisconsin:										
Ashland			11,600	695						
Bayfield			1,645,805	30,528			68,000	2,340		
Douglas			69,000	2,065						
Iron			8,000	200						
Total			1,734,405	33,488			68,000	2,340		
Minnesota:										
Cook			1,375,239	43,658	1,651,178	$75,405	1,593,925	67,948		
Lake			559,465	19,208	1,100,786	50,270	995,302	43,242		
St. Louis			1,099,403	33,523	550,393	25,135	600,500	26,406	5,400	$432
Total			3,034,107	96,389	3,302,357	150,810	3,189,727	137,596	5,400	432
Grand total	2,675	170	5,692,498	169,048	3,302,357	150,810	3,258,227	139,959	5,400	432

State and county.	Pike.		Pike perch (wall-eyed or yellow pike).		Suckers. Fresh.		Suckers. Salted.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Michigan:								
Alger			243	$40	23,165	$980		
Baraga			60	6	3,200	133		
Chippewa	800	$80	3,470	525	100,713	4,305		
Gogebic			50	5	1,000	25		
Houghton			500	20	1,600	76		
Keweenaw			231	59	5,464	218		
Marquette			325	26	21,271	695		
Ontonagon					18,835	684		
Total	800	80	4,879	681	175,248	7,116		
Wisconsin:								
Ashland	3,300	355	3,300	469	19,000	890		
Bayfield	1,600	120	19,800	2,624	104,900	4,100	15,850	$560
Total	4,900	475	23,100	3,093	123,900	4,990	15,850	560
Minnesota:								
Cook					100	2		
Lake					1,000	55		
St. Louis					25,955	1,021		
Total					27,055	1,078		
Grand total	5,700	555	27,979	3,774	326,203	13,184	15,850	560

STATISTICS OF THE FISHERIES OF LAKE SUPERIOR IN 1917, BY STATES AND COUNTIES—Continued.

YIELD, BY SPECIES—Continued.

State and county.	Lake trout.						Whitefish, common.	
	Fresh.		Frozen.		Salted.			
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Michigan:								
Alger	174,557	$14,399					30,846	$3,280
Baraga	10,500	1,059					2,525	223
Chippewa	422,188	30,075					142,044	14,074
Gogebic	21,750	1,550					12,000	1,000
Houghton	170,325	16,206					19,080	1,711
Keweenaw	232,850	21,011					8,933	979
Marquette	395,499	34,340					11,635	1,455
Ontonagon	109,182	8,734					15,199	1,639
Total	1,536,851	127,374					242,262	24,361
Wisconsin:								
Ashland	8,875	685					1,200	112
Bayfield	573,720	46,459					41,295	4,145
Iron	12,500	1,000					360	40
Total	595,095	48,144					42,855	4,297
Minnesota:								
Cook	83,642	8,710			3,700	$268	1,047	147
Lake	110,646	9,909			1,372	92	3,400	350
St. Louis	210,847	15,460	44,000	$5,800	2,200	216	12,646	1,788
Total	405,135	34,079	44,000	5,800	7,272	576	17,093	2,285
Grand total	2,537,081	209,597	44,000	5,800	7,272	576	302,210	30,943

State and county.	Whitefish, menominee.				Yellow perch.		Total.	
	Fresh.		Salted.					
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Michigan:								
Alger							233,411	$18,917
Baraga							111,485	5,451
Chippewa					3,000	$235	857,277	57,719
Gogebic							51,800	3,260
Houghton	500	$40					371,605	26,019
Keweenaw	430	48					324,408	25,969
Marquette	300	22					754,139	49.373
Ontonagon							187,306	12,613
Total	1,230	110			3,000	235	2,891,431	199,321
Wisconsin:								
Ashland							47,275	3,206
Bayfield	4,050	178			2,000	121	2,477,020	91,175
Douglas							69,000	2,065
Iron							20,860	1,240
Total	4,050	178			2,000	121	2,614,155	97,686
Minnesota:								
Cook	200	20	100	$4			4,709,131	196,162
Lake	2,200	174					2,774,171	123,300
St. Louis	4,400	200	2,800	224			2,558,544	110,205
Total	6,800	394	2,900	228			10,041,846	429,667
Grand total	12,080	682	2,900	228	5,000	356	15,547,432	726,674

FISHERIES, BY APPARATUS.

The catch of the vessel fisheries amounted to 3,259,811 pounds, valued at $123,169, and of the shore or boat fisheries to 12,287,621 pounds, valued at $603,505. In the vessel fisheries the catch of ciscoes, suckers, lake trout, and whitefish with gill nets amounted to 3,164,811 pounds, valued at $116,369, the balance of the catch consisting of lake trout taken with set lines. In the shore fisheries 11,095,696 pounds consisting of bowfin, ciscoes, pike, pike perch, suckers, lake trout, and whitefish, valued at $523,260, were taken with gill nets; 901,873 pounds, including ciscoes, pike, pike perch, suckers, lake trout, whitefish, and yellow perch, valued at $63,610, with pound nets and trap nets; 177,300 pounds of lake trout, valued at $15,708, with lines; and 12,752 pounds of ciscoes, suckers, lake trout, and whitefish, valued at $927, with seines.

The following tables give the products of the vessel and shore fisheries, by States and counties, in 1917:

YIELD OF VESSEL FISHERIES OF LAKE SUPERIOR IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES.

Apparatus and species.	Michigan.					
	Chippewa.		Marquette.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Gill nets:						
Ciscoes	33,995	$1,698	292,609	$11,444	326,604	$13,142
Suckers			8,471	255	8,471	255
Trout, lake	266,625	18,960	318,499	27,006	585,124	45,966
Whitefish—						
Common			9,487	1,187	9,487	1,187
Menominee			300	22	300	22
Total	300,620	20,658	629,366	39,914	929,986	60,572
Set lines: Trout, lake	75,000	4,800			75,000	4,800
Grand total	375,620	25,458	629,366	39,914	1,004,986	65,372

Apparatus and species.	Wisconsin.		Minnesota.		Grand total.	
	Bayfield.		St. Louis.			
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Gill nets:						
Ciscoes	1,273,105	$21,246	800,000	$23,712	2,399,709	$58,100
Suckers					8,471	255
Trout, lake	13,595	1,359	148,125	9,480	746,844	56,805
Whitefish—						
Common					9,487	1,187
Menominee					300	22
Total	1,286,700	22,605	948,125	33,192	3,164,811	116,369
Set lines: Trout, lake	20,000	2,000			95,000	6,800
Grand total	1,306,700	24,605	948,125	33,192	3,259,811	123,169

YIELD OF SHORE FISHERIES OF LAKE SUPERIOR IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Michigan.									
	Alger.		Baraga.		Chippewa.		Gogebic.		Houghton.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Pound nets and trap nets:										
Ciscoes—										
Fresh			82,800	$3,410	5,000	$200			1,000	$36
Salted	500	$23								
Pike					800	80				
Pike perch (wall-eyed or yellow pike)	243	40			3,470	525				
Suckers, fresh	4,805	188	2,300	105	90,713	3,805				
Trout, lake	24,102	1,971	5,625	565	13,063	890			3,750	560
Whitefish, common	25,752	2,727	2,255	198	135,444	13,415				
Yellow perch					3,000	235				
Total	55,402	4,949	92,980	4,278	251,490	19,150			4,750	596
Gill nets:										
Ciscoes, fresh	3,600	170	12,400	620	146,067	6,527	17,000	$680	174,800	7,770
Pike perch (wall-eyed or yellow pike)			60	6			50	5	500	20
Suckers, fresh	16,360	692	900	28	10,000	500	1,000	25	600	26
Trout, lake, fresh	116,012	9,653	4,875	494	35,625	2,875	21,750	1,550	147,825	13,821
Whitefish—										
Common	810	71	270	25	6,600	659	12,000	1,000	18,480	1,646
Menominee, fresh									500	40
Total	136,782	10,586	18,505	1,173	198,292	10,561	51,800	3,260	342,705	23,323
Seines:										
Ciscoes	500	25							3,800	160
Suckers	2,000	100							1,000	50
Trout	568	45								
Whitefish	4,284	482							600	65
Total	7,352	652							5,400	275
Lines: Trout, lake	33,875	2,730			31,875	2,550			18,750	1,825
Grand total	233,411	18,917	111,485	5,451	481,657	32,261	51,800	3,260	371,605	26,019

Apparatus and species.	Michigan—Continued.							
	Keweenaw.		Marquette.		Ontonagon.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Pound nets and trap nets:								
Ciscoes—								
Fresh	5,000	$250	500	$21			94,300	$3,917
Salted							500	23
Pike							800	80
Pike perch (wall-eyed or yellow pike)	166	37					3,879	602
Suckers, fresh	3,302	132	1,500	45			102,620	4,275
Trout, lake	65,725	7,811	3,125	310	7,500	$600	122,890	12,707
Whitefish—								
Common	2,933	394	600	75	3,600	420	170,584	17,229
Menominee	355	38					355	38
Yellow perch							3,000	235
Total	77,481	8,662	5,725	451	11,100	1,020	498,928	39,106

YIELD OF SHORE FISHERIES OF LAKE SUPERIOR IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Michigan—Continued.							
	Keweenaw.		Marquette.		Ontonagon.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Gill nets:								
Bowfin	2,675	$170					2,675	$170
Ciscoes, fresh	68,825	3,234	32,000	$1,370	44,090	$1,556	498,782	21,927
Pike perch (wall-eyed or yellow pike)	65	22	325	26			1,000	79
Suckers, fresh	2,162	86	11,300	395	18,835	684	61,157	2,436
Trout, lake, fresh	164,625	12,970	72,125	6,860	91,682	7,334	654,519	55,557
Whitefish—								
Common	6,000	585	1,548	193	11,599	1,219	57,307	5,398
Menominee, fresh	75	10					575	50
Total	244,427	17,077	117,298	8,844	166,206	10,793	1,276,015	85,617
Seines:								
Ciscoes							4,300	185
Suckers							3,000	150
Trout							568	45
Whitefish							4,884	547
Total							12,752	927
Lines: Trout, lake	2,500	230	1,750	164	10,000	800	98,750	8,299
Grand total	324,408	25,969	124,773	9,459	187,306	12,613	1,886,445	133,949

Apparatus and species.	Wisconsin.									
	Ashland.		Bayfield.		Douglas.		Iron.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Pound nets and trap nets:										
Ciscoes—										
Fresh	600	$20	62,500	$1,657					63,100	$1,677
Salted			23,000	690					23,000	690
Pike	800	55	1,600	120					2,400	175
Pike perch (wall-eyed or yellow pike)	2,800	399	16,300	2,142					19,100	2,541
Suckers—										
Fresh	12,000	515	95,500	3,735					107,500	4,250
Salted			15,000	525					15,000	525
Trout, lake	750	60	120,750	9,695					121,500	9,755
Whitefish—										
Common	600	56	26,895	2,745					27,495	2,801
Menominee			150	7					150	7
Yellow perch			1,700	103					1,700	103
Total	17,550	1,105	363,395	21,419					380,945	22,524
Gill nets:										
Ciscoes—										
Fresh	11,000	675	310,200	7,625	69,000	$2,065	8,000	$200	398,200	10,565
Salted			45,000	1,650					45,000	1,650
Pike	2,500	300							2,500	300
Pike perch (wall-eyed or yellow pike)	500	70	3,500	482					4,000	552
Suckers—										
Fresh	7,000	375	9,400	365					16,400	740
Salted			850	35					850	35
Trout, lake, fresh	6,250	475	362,500	27,870			12,500	1,000	381,250	29,345
Whitefish—										
Common	600	56	14,400	1,400			360	40	15,360	1,496
Menominee, fresh			3,900	171					3,900	171
Yellow perch			300	18					300	18
Total	27,850	1,951	750,050	39,616	69,000	2,065	20,860	1,240	867,760	44,872
Lines: Trout, lake	1,875	150	56,875	5,535					58,750	5,685
Grand total	47,275	3,206	1,170,320	66,570	69,000	2,065	20,860	1,240	1,307,455	73,081

YIELD OF SHORE FISHERIES OF LAKE SUPERIOR IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Minnesota.								Grand total.	
	Cook.		Lake.		St. Louis.		Total.			
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Pound nets and trap nets:										
Ciscoes—										
Fresh									157,400	$5,594
Salted									23,500	713
Pike									3,200	255
Pike perch (wall-eyed or yellow pike)									22,979	3,143
Suckers—										
Fresh					12,000	$480	12,000	$480	222,120	9,005
Salted									15,000	525
Trout, lake									244,390	22,462
Whitefish—										
Common					10,000	1,500	10,000	1,500	208,079	21,530
Menominee									505	45
Yellow perch									4,700	338
Total					22,000	1,980	22,000	1,980	901,873	63,610
Gill nets:										
Bowfin									2,675	170
Ciscoes—										
Fresh	1,375,239	$43,658	559,465	$19,208	299,403	9,811	2,234,107	72,677	3,131,089	105,169
Frozen	1,651,178	75,405	1,100,786	50,270	550,393	25,135	3,302,357	150,810	3,302,357	150,810
Salted	1,593,925	67,948	995,302	43,242	600,500	26,406	3,189,727	137,596	3,134,727	139,246
Smoked					5,400	432	5,400	432	5,400	432
Pike									2,500	300
Pike perch (wall-eyed or yellow pike)									5,000	631
Suckers—										
Fresh	100	2	1,000	55	13,955	541	15,055	598	92,612	3,774
Salted									850	35
Trout, lake—										
Fresh	82,842	8,646	106,646	9,549	47,722	4,680	237,210	22,875	1,272,979	107,777
Frozen					44,000	5,800	44,000	5,800	44,000	5,800
Salted	3,700	268	1,372	92	2,200	216	7,272	576	7,272	576
Whitefish—										
Common	1,047	147	3,400	350	2,646	288	7,093	785	79,760	7,679
Menominee, fresh	200	20	2,200	174	4,400	200	6,800	394	11,275	615
Menominee, salted	100	4			2,800	224	2,900	228	2,900	228
Yellow perch									300	18
Total	4,708,331	196,098	2,770,171	122,940	1,573,419	73,733	9,051,921	392,771	11,095,696	523,260
Seines:										
Ciscoes									4,300	185
Suckers									3,000	150
Trout									568	45
Whitefish									4,884	547
Total									12,752	927
Lines: Trout, lake	800	64	4,000	360	15,000	1,300	19,800	1,724	177,300	15,708
Grand total	4,709,131	196,162	2,774,171	123,300	1,610,419	77,013	9,093,721	396,475	12,287,621	603,505

WHOLESALE FISHERY TRADE.

The wholesale fishery trade of Lake Superior in 1917 was conducted by 15 establishments, of which 8 were at Duluth, 2 at Bayfield, and 1 at each of the following places: Ashland, Bark Point, Port Wing, Superior, and Sault Ste. Marie. The total number of persons employed in these establishments was 249, to whom $65,353 were paid in wages during the year; the investment in shore and accessory property amounted to $210,400 and the cash capital utilized was $42,500. Compared with 1903, there was a decrease of 1 in the num-

ber of establishments and of $100,200 in cash capital, and an increase of 150 employees, of $6,773 in the amount of wages paid, and of $103,986 in the value of the property.

The following table shows by localities the extent of the wholesale fishery trade of Lake Superior in 1917:

WHOLESALE FISHERY TRADE OF LAKE SUPERIOR IN 1917.

Cities and towns.	State.	Number of firms.	Persons engaged.	Wages paid.	Shore and accessory property.	Cash capital.
Duluth	Minnesota	8	77	$35,742	$146,350	$23,000
Ashland, Bayfield, and Bark Point	Wisconsin	4	140	19,125	21,325	12,500
Port Wing, Superior, and Sault Ste. Marie.	Wisconsin and Michigan.	3	32	10,486	42,725	7,000
Total		15	249	65,353	210,400	42,500

FISHERIES OF LAKE MICHIGAN.

In 1917 Lake Michigan ranked first among the Great Lakes in the number of persons employed in the fisheries and second in the amount of invested capital and the quantity and value of the products. The total number of persons employed in the fisheries of Lake Michigan was 3,313, of whom 1,096 were on fishing vessels, 81 on vessels transporting fishery products, 1,285 in the shore fisheries, and 851 shoresmen in the wholesale fishery trade, etc. Of the total number of persons engaged 1,537 were credited to Wisconsin, 1,145 to Michigan, 564 to Illinois, and 67 to Indiana.

The total investment in the fisheries of the lake amounted to $4,038,927. The number of vessels fishing was 332, with a net tonnage of 3,913 tons, valued at $631,960, and having outfits to the value of $179,521; and of transporting vessels, 60 with net tonnage of 495 tons, valued at $38,225, with outfits valued at $4,515. The number of boats was 739, worth $101,538. The fishing apparatus used on vessels was valued at $561,349, and on boats at $413,678. Shore and accessory property amounted to $1,758,341 and cash capital to $349,800. The investment was divided among the different States as follows: Wisconsin, $1,514,295, or 37.49 per cent; Illinois, $1,265,664, or 31.34 per cent; Michigan, $1,179,143, or 29.19 per cent; and Indiana, $79,825, or 1.98 per cent.

Gill nets were the most important apparatus of capture, 57,453, representing a value of $535,616, being employed in the vessel fisheries, and 26,354, valued at $109,458, in the boat fisheries, a total in both fisheries of 83,807, amounting in value to $645,074. Lines valued at $27,868 were employed in both the vessel and shore fisheries. Other apparatus used in the shore fisheries included 1,134 pound nets and trap nets, valued at $242,570; 3,343 fyke nets, valued at $39,795; 61 seines, valued at $18,120; and 6,400 crawfish pots, valued at $1,600.

The fishery products of Lake Michigan amounted to 35,460,628 pounds, valued at $2,270,859. This total was divided among the different States as follows: Wisconsin, 21,453,679 pounds, valued at $1,225,084; Michigan, 11,634,480 pounds, valued at $883,301; Illinois, 1,356,294 pounds, valued at $87,375; and Indiana, 1,016,175 pounds, valued at $75,099. The more important species taken in

this lake were ciscoes, 18,259,354 pounds, valued at $845,982; lake trout, 8,650,715 pounds, valued at $853,138; common whitefish, 3,047,393 pounds, valued at $323,363; yellow perch, 2,362,796 pounds, valued at $116,500; and suckers, 2,118,563 pounds, valued at $75,484.

As compared with 1903 there was an increase of 72, or 2.22 per cent, in the number of persons employed; $549,740, or 15.76 per cent, in the investment in the fisheries; and 1,881,130 pounds, or 5.60 per cent, in quantity; and $1,180,309, or 108.23 per cent, in the value of the products.

FISHERIES, BY STATES AND COUNTIES.

The following tables show by States and counties the extent of the fisheries of Lake Michigan in 1917:

STATISTICS OF THE FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES AND COUNTIES.

PERSONS EMPLOYED.

State and county.	On vessels fishing.	On vessels transporting.	In shore or boat fisheries.	Shoresmen.	Total.
Michigan:					
Allegan			9		9
Antrim			10		10
Benzie	49	2	6	19	76
Berrien	38		33	2	73
Charlevoix	96	2	30	21	149
Delta	11		157	6	174
Emmet			28		28
Grand Traverse	10	2	23		35
Leelanau	50		34	7	91
Mackinac	16	2	75		93
Manistee	16		11	2	29
Mason	26	2	15		43
Menominee		22	61	36	119
Muskegon	8	1	30		39
Oceana	6				6
Ottawa	50		18	11	79
Schoolcraft	47		20	4	71
Van Buren	13		8		21
Total	436	33	568	108	1,145
Indiana:					
Lake			10		10
Laporte	21		21	3	45
Porter			12		12
Total	21		43	3	67
Illinois:					
Cook	31		15	482	528
Lake	24		12		36
Total	55		27	482	564
Wisconsin:					
Brown	53	22	200	107	382
Door	143	5	174	10	332
Kenosha	9		1	4	14
Kewaunee	33		6		39
Manitowoc	42		22	20	84
Marinette	75	10	81	32	198
Milwaukee	77		24	26	127
Oconto	52	9	95		156
Ozaukee	26	2	11	18	57
Racine	23		2	10	35
Sheboygan	51		31	31	113
Total	584	48	647	258	1,537
Grand total	1,096	81	1,285	851	3,313

STATISTICS OF THE FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES AND COUNTIES—Continued.

INVESTMENT.

State and county.	Vessels, fishing.								Vessels transporting.			
	Steam.				Gasoline.				Gasoline.			
	No.	Tonnage.	Value.	Outfit.	No.	Tonnage.	Value.	Outfit.	No.	Tonnage.	Value.	Outfit.
Michigan:												
Benzie	7	113	$20,150	$11,500	5	46	$4,200	$2,715	1	6	$450	$50
Berrien	5	153	32,700	4,890	2	15	1,500	125				
Charlevoix	8	114	18,700	9,210	18	141	16,000	6,650	1	7	300	225
Delta	2	26	3,000	1,600								
Grand Traverse					4	43	3,800	1,200	1	9	1,000	20
Leelanau	5	57	9,600	5,925	12	96	11,250	3,350				
Mackinac					7	43	3,350	990	2	16	900	240
Manistee					7	49	7,000	3,435				
Mason	2	21	4,000	415	9	79	6,550	2,115	2	16	850	95
Menominee									9	124	10,700	1,285
Muskegon					4	27	4,500	800	1	8	600	50
Oceana					3	23	2,950	1,000				
Ottawa	8	143	31,100	9,875								
Schoolcraft	4	100	10,500	6,500	6	53	4,250	1,675				
Van Buren	2	31	4,700	2,125	1	6	600	150				
Total	43	758	134,450	52,040	78	616	65,950	24,205	17	186	14,800	1,965
Indiana: Laporte	2	51	11,000	3,610	1	8	1,200	850				
Illinois:												
Cook					8	73	17,200	4,095				
Lake					5	55	13,500	3,100				
Total					13	128	30,700	7,195				
Wisconsin:												
Brown	1	9	1,000	200	23	192	14,800	1,300	22	140	10,350	875
Door	5	92	17,500	1,950	47	423	43,650	3,881	4	34	2,500	130
Kenosha	1	32	5,000	1,650	1	14	1,400	800				
Kewanee	2	27	4,000	1,500	12	112	10,400	1,880				
Manitowoc	2	51	5,500	2,785	11	149	15,900	6,550				
Marinette	4	46	9,700	2,800	22	173	21,700	3,500	7	74	4,900	950
Milwaukee	13	254	83,000	20,000	4	33	3,800	2,450				
Oconto					26	201	15,810	1,325	9	51	5,375	395
Ozaukee	4	100	30,500	9,500	1	15	2,000	200	1	10	300	200
Racine	5	118	31,000	7,250								
Sheboygan	10	257	65,000	19,600	1	49	7,000	2,500				
Total	47	986	252,200	67,235	148	1,361	136,460	24,386	43	309	23,425	2,550
Grand total	92	1,795	397,650	122,885	240	2,118	234,310	56,636	60	495	38,225	4,515

STATISTICS OF THE FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES AND COUNTIES—Continued.

INVESTMENT—Continued.

State and county.	Sail and row boats.		Power boats.		Apparatus of capture, vessel fisheries.			Apparatus of capture, shore fisheries.			
					Gill nets.		Value of lines.	Pound nets and trap nets.		Gill nets.	
	No.	Value	No.	Value.	No.	Value.		No.	Value.	No.	Value.
Michigan:											
Allegan	5	$115	4	$750				7	$1,475	146	$1,447
Antrim	7	100	3	350				6	725	48	370
Benzie	2	50	3	700	1,875	$29,074		6	460	55	545
Berrien	15	335	9	4,000	3,757	35,552		11	3,550	671	6,640
Charlevoix	6	85	18	6,625	6,702	61,048	$1,500	31	6,005	633	6,309
Delta	66	1,053	35	10,115	880	5,300		136	16,090	2,938	19,810
Emmet	14	300	5	1,625				12	5,100	237	2,445
Grand Traverse	17	340	8	2,150	199	1,841		106	7,995	139	1,450
Leelanau	18	390	9	1,825	2,588	20,290		48	5,865	174	1,070
Mackinac	10	145	27	6,580	242	1,786	4	152	20,725	375	3,320
Manistee	9	165	5	550	890	8,600	1,535	13	1,180	156	766
Mason	13	345			1,317	14,496	700	79	6,400	14	150
Menominee	10	320	26	7,850				80	24,675	161	954
Muskegon	24	519	2	750	269	2,748	600	39	5,800	133	1,156
Oceana					350	3,500	750				
Ottawa	16	361	3	900	7,275	54,200	1,650	19	2,425	112	1,120
Schoolcraft	5	115	8	2,975	1,677	15,045		42	5,950	253	2,105
Van Buren	4	90	3	550	1,812	14,248				171	1,710
Total	241	4,828	168	48,295	29,833	267,728	6,739	787	114,420	6,416	51,367
Indiana:											
Lake	4	125	6	1,200				5	1,100	210	4,460
Laporte	10	255	6	1,400	1,695	35,940	200	7	3,800	102	1,530
Porter	9	230	2	450				6	2,700	57	1,140
Total	23	610	14	3,050	1,695	35,940	200	18	7,600	369	7,130
Illinois:											
Cook	7	125	1	1,500	705	7,125				80	845
Lake	2	70	3	1,300	1,650	13,100		8	3,000	110	800
Total	9	195	4	2,800	2,355	20,225		8	3,000	190	1,645
Wisconsin:											
Brown	62	1,810	23	6,500	1,506	7,686		24	3,600	1,785	8,925
Door	14	545	43	11,750	8,730	76,330	7,324	97	23,450	14,315	21,065
Kenosha	1	20			597	4,500				4	35
Kewaunee	1	30	3	700	1,080	9,530	6,650	3	900		
Manitowoc	6	120	8	2,875	1,507	16,248		29	25,500	31	165
Marinette	9	250	13	3,900	5,365	46,675		43	15,800	2,070	8,560
Milwaukee	13	230	5	2,650	1,868	23,060		2	400	165	1,470
Oconto	34	995	18	5,400	1,373	9,529		93	17,900	954	8,586
Ozaukee			3	1,375	1,051	8,600	425	6	5,000	10	85
Racine	1	20	1	150	58	865	1,000			20	250
Sheboygan	14	290	8	2,150	435	8,700	3,395	24	25,000	25	175
Total	155	4,310	125	37,450	23,570	211,723	18,794	321	117,550	19,379	49,316
Grand total	428	9,943	311	91,595	57,453	535,616	25,733	1,134	242,570	26,354	109,458

STATISTICS OF THE FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES AND COUNTIES—Continued.

INVESTMENT—Continued.

State and county.	Apparatus of capture, shore fisheries—Continued. Fyke nets. No.	Fyke nets. Value.	Seines. No.	Seines. Value.	Value of lines.	Crawfish pots. No.	Crawfish pots. Value.	Shore and accessory property.	Cash capital.	Total investment.
Michigan:										
Allegan								$1,275		$5,062
Antrim					$70			310		1,925
Benzie								15,145		85,039
Berrien			1	$150	25			8,705	$2,000	100,172
Charlevoix								34,540	7,000	174,197
Delta	27	$5,395						14,040	2,500	78,903
Emmet					250			1,675		11,395
Grand Traverse					120			4,675		24,591
Leelanau					40			21,835		81,440
Mackinac								4,415		42,455
Manistee								4,600		27,831
Mason					70			2,975		39,161
Menominee	30	1,000						97,961	80,000	224,745
Muskegon								3,420		20,943
Oceana										8,200
Ottawa								34,865	32,000	168,496
Schoolcraft								7,000	3,500	59,615
Van Buren								800		24,973
Total	57	6,395	1	150	575			258,236	127,000	1,179,143
Indiana:										
Lake					60			1,250		8,195
Laporte								5,075	1,000	65,860
Porter								1,250		5,770
Total					60			7,575	1,000	79,825
Illinois:										
Cook					35			1,085,769	112,500	1,229,194
Lake								1,600		36,470
Total					35			1,087,369	112,500	1,265,664
Wisconsin:										
Brown	2,771	27,710	48	15,500		6,400	$1,600	160,169	79,500	341,525
Door			5	1,250	800			20,385	6,500	239,010
Kenosha								6,000		19,405
Kewaunee					130			650		36,370
Manitowoc			2	200				27,385	1,800	105,028
Marinette	27	810						29,097	9,000	157,642
Milwaukee					20			87,500	10,000	234,580
Oconto	488	4,880	3	900				7,125		78,220
Ozaukee					500			23,500	1,000	83,185
Racine					15			7,400		47,950
Sheboygan			2	120				35,950	1,500	171,380
Total	3,286	33,400	60	17,970	1,465	6,400	1,600	405,161	109,300	1,514,295
Grand total	3,343	39,795	61	18,120	2,135	6,400	1,600	1,758,341	349,800	4,038,927

STATISTICS OF THE FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES AND COUNTIES—Continued.

YIELD, BY SPECIES.

State and county.	Burbot.		Carp, Asiatic.		Catfish and bullheads.		Ciscoes.			
							Fresh.		Salted.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Michigan:										
Allegan			300	$12			7,633	$466	2,437	$142
Antrim							14,520	832		
Benzie	4,870	$89					176,920	10,268		
Berrien	2,870	66	400	16			475,171	30,384		
Charlevoix	8,739	195					244,476	12,312		
Delta	565	7					236,098	8,529	114,329	4,510
Emmet							3,168	170		
Grand Traverse	1,100	20					31,760	1,934		
Leelanau							262,617	13,532		
Mackinac							10,575	370		
Manistee							85,097	4,374		
Mason	6,850	204	130	5			187,531	12,239		
Menominee	300	3					217,919	8,280	402,960	18,922
Muskegon	200	6	410	16			138,707	8,904		
Oceana							24,000	1,440		
Ottawa	1,572	32	600	23			935,501	53,316		
Schoolcraft							26,226	1,071		
Van Buren							81,216	5,389		
Total	27,066	622	1,840	72			3,159,135	173,810	519,726	23,574
Indiana:										
Lake	625	13	400	16			86,500	5,085		
Laporte	2,164	107	650	26	120	$17	641,730	43,353		
Porter	350	10	100	4			85,600	4,275		
Total	3,139	130	1,150	46	120	17	813,830	52,713		
Illinois:										
Cook	58	1					580,098	31,825		
Lake							435,720	22,315		
Total	58	1					1,015,818	54,140		
Wisconsin:										
Brown	86,886	435	213,453	6,404	148,577	5,979	1,078,433	35,049	58,360	2,762
Door	46,194	231					1,595,733	51,861	1,788,550	86,388
Kenosha							292,874	16,084		
Kewaunee							423,016	13,748		
Manitowoc			2,760	141			755,762	42,855		
Marinette	1,842	9			3,969	159	2,396,248	78,575	317,135	15,318
Milwaukee			200	12			1,069,310	61,420		
Oconto	1,600	8	26,500	795	11,800	472	1,445,931	46,992	233,995	11,302
Ozaukee							342,140	21,793		
Racine							20,400	1,150		
Sheboygan			600	30			932,958	56,448		
Total	136,522	683	243,513	7,382	164,346	6,610	10,352,805	425,975	2,398,040	115,770
Grand total	166,785	1,436	246,503	7,500	164,466	6,627	15,341,588	706,638	2,917,766	139,344

State and county.	Pike.		Pike perch (wall-eyed or yellow pike).		Rock bass.		Sheepshead or drum.		Sturgeon.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Michigan:										
Allegan			4,758	$655			1,600	$64	895	$205
Berrien			1,100	126			300	12	3,520	943
Charlevoix									40	5
Delta	6,230	$623	56,231	6,425					763	94
Emmet			75	9						
Grand Traverse									35	3
Mackinac									890	124
Manistee	519	27	5,585	818					943	144
Mason	900	90	11,775	2,553			200	8	68	16
Menominee	71	6	1,065	128					361	72
Muskegon	300	30	5,378	804			7,000	280	434	104
Ottawa			2,523	365			1,315	48	360	108
Schoolcraft			523	104					50	6
Van Buren									50	13
Total	8,020	776	89,016	11,987			10,415	412	8,409	1,837

STATISTICS OF THE FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES AND COUNTIES—Continued.

YIELD, BY SPECIES—Continued.

State and county.	Pike.		Pike perch (wall-eyed or yellow pike).		Rock bass.		Sheepshead or drum.		Sturgeon.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Indiana:										
Lake									1,514	$406
Laporte	175	$26	1,400	$240			750	$30	482	162
Porter	50	4							400	112
Total	225	30	1,400	240			750	30	2,396	680
Wisconsin:										
Brown	3,518	281	18,289	2,743			16,929	338		
Door	8,972	717	662	99	1,714	$137	318	16		
Marinette	6,562	505	1,618	221						
Oconto	13,100	1,048	21,039	3,155						
Sheboygan	200	18								
Total	32,352	2,569	41,608	6,218	1,714	137	17,247	354		
Grand total	40,597	3,375	132,024	18,445	1,714	137	28,412	796	10,805	2,517

State and county.	Sturgeon caviar.		Suckers.				Trout, lake.			
			Fresh.		Salted.		Fresh.		Salted.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Michigan:										
Allegan	16	$32	5,832	$249			1,016	$139		
Antrim			3,250	208			4,440	470		
Benzie			22,261	892			326,945	29,396		
Berrien	190	570	10,442	711			250,189	26,658		
Charlevoix			8,963	284	100	$4	1,063,698	68,803		
Delta			577,334	24,597			138,664	11,539		
Emmet			3,600	149			96,398	7,456		
Grand Traverse			187,351	6,496			34,049	2,867		
Leelanau			47,639	1,921			434,587	32,213		
Mackinac			33,926	1,697			85,447	7,261	200	$22
Manistee			29,381	1,178			168,168	16,903		
Mason			62,132	3,531			149,563	16,617		
Menominee			3,754	150	345	16	10,753	968	345	16
Muskegon	50	125	14,408	816			20,903	2,400		
Oceana							46,450	7,013		
Ottawa	25	62	1,302	51			240,753	29,447		
Schoolcraft			23,785	1,415	2,100	74	378,964	30,805		
Van Buren			1,442	100			63,271	7,481		
Total	281	789	1,036,802	44,445	2,545	94	3,514,258	298,436	545	38
Indiana:										
Lake	55	100	740	30			19,100	2,350		
Laporte	10	15	2,000	80			103,010	10,746		
Porter			450	22			1,300	130		
Total	65	115	3,190	132			123,410	13,226		
Illinois:										
Cook							515	37		
Lake			5,265	200			168,125	18,075		
Total			5,265	200			168,640	18,112		
Wisconsin:										
Brown			537,770	12,559	2,600	122				
Door			64,635	2,323	8,160	371	802,519	81,736	1,830	186
Kenosha							180,346	19,616		
Kewaunee			3,862	93			461,813	47,952	215	17
Manitowoc			18,763	799			452,220	41,546		
Marinette			212,899	8,938			134,690	12,465		
Milwaukee			2,105	88			1,075,831	110,677		
Oconto			209,912	4,897	805	38	15,144	1,575	230	18
Ozaukee			2,800	131			302,128	30,700		
Racine							527,125	72,800		
Sheboygan			6,450	254			889,771	104,038		
Total			1,059,196	30,082	11,565	531	4,841,587	523,105	2,275	221
Grand total	346	904	2,104,453	74,859	14,110	625	8,647,895	852,879	2,820	259

STATISTICS OF THE FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES AND COUNTIES—Continued.

YIELD, BY SPECIES—Continued.

State and county.	Trout, steel-head.		White bass.		Whitefish, common.				Whitefish, menominee.	
					Fresh.		Salted.		Fresh.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Michigan										
Allegan			250	$15	11,247	$1,530				
Antrim					11,156	1,186			240	$18
Benzie					693,388	73,988			30	1
Berrien					27,636	3,781				
Charlevoix					492,552	49,615	1,200	$96	19,568	1,190
Delta					152,428	14,566			1,772	95
Emmet					42,587	4,786			3,000	210
Grand Traverse					41,268	5,812				
Leelanau					423,877	37,345			1,422	91
Mackinac					529,510	53,476	745	105	23,233	1,265
Manistee					29,352	3,558				
Mason					16,317	2,151				
Menominee					4,254	468			49	4
Muskegon	700	$117	350	35	7,615	1,114				
Oceana					1,518	258				
Ottawa					6,862	832				
Schoolcraft					323,941	40,825			27,373	1,002
Van Buren					24,360	3,303				
Total	700	117	600	50	2,839,868	298,594	1,945	201	76,687	3,876
Indiana:										
Lake	19,200	2,880			300	42				
Laporte	900	180			3,550	637				
Porter	1,150	172			300	43				
Total	21,250	3,232			4,150	722				
Illinois, Lake					33,600	4,750				
Wisconsin:										
Brown			675	27	600	67				
Door					48,002	4,950			23,145	926
Kewaunee					1,000	112				
Manitowoc					42,582	4,451				
Marinette					26,672	2,805				
Milwaukee					4,680	571				
Oconto					14,344	1,607				
Ozaukee					5,040	545				
Sheboygan					24,910	3,988			500	27
Total			675	27	167,830	19,096			23,645	953
Grand total	21,950	3,349	1,275	77	3,045,448	323,162	1,945	201	100,332	4,829

STATISTICS OF THE FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES AND COUNTIES—Continued.

YIELD, BY SPECIES—Continued.

State and county.	Whitefish, menominee—Continued.		Yellow perch.				Crawfish.		Total.	
	Salted.		Fresh.		Salted.					
	Lbs.	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*
Michigan:										
Allegan			1,148	$91					37,132	$3,600
Antrim									33,606	2,714
Benzie			1,300	112					1,225,714	114,746
Berrien			11,964	1,340					783,782	64,607
Charlevoix	7,400	$553	52,088	3,170					1,898,824	136,227
Delta			176,204	12,035					1,460,621	83,020
Emmet			5,800	460					154,628	13,240
Grand Traverse			4,157	362					299,720	17,494
Leelanau	698	47	3,391	287					1,174,231	85,436
Mackinac	7,500	557	380	19					692,406	64,896
Manistee			9,815	295					328,860	27,297
Mason			5,013	511					440,479	37,925
Menominee			4,561	180	1,725	$81			648,462	29,294
Muskegon			8,137	654					204,592	15,405
Oceana									71,968	8,711
Ottawa			21,818	1,703					1,212,631	85,987
Schoolcraft	9,700	776							792,662	76,078
Van Buren			3,823	338					174,162	16,624
Total	25,298	1,933	309,599	21,557	1,725	81			11,634,480	883,301
Indiana:										
Lake			18,300	1,785					146,734	12,707
Laporte			18,600	1,641					775,541	57,260
Porter			4,200	360					93,900	5,132
Total			41,100	3,786					1,016,175	75,099
Illinois:										
Cook			80,613	7,157					661,284	39,020
Lake			52,300	3,015					695,010	48,355
Total			132,913	10,172					1,356,294	87,375
Wisconsin:										
Brown			1,122,303	44,892			80,495	$4,427	3,368,888	116,085
Door	805	40	135,232	5,410					4,526,471	235,391
Kenosha			6,360	474					479,580	36,174
Kewaunee			17,832	713					907,738	62,635
Manitowoc			15,968	1,380					1,288,055	91,172
Marinette			110,421	4,417					3,212,056	123,412
Milwaukee			117,360	8,974					2,269,486	181,742
Oconto			338,733	13,549					2,333,133	85,456
Ozaukee			2,500	195					654,668	53,364
Racine			5,950	445					553,475	74,395
Sheboygan			4,800	455					1,860,189	165,258
Total	805	40	1,877,459	80,904			80,495	4,427	21,453,679	1,225,084
Grand total	26,103	1,973	2,361,071	116,419	1,725	81	80,495	4,427	35,460,628	2,270,859

FISHERIES, BY APPARATUS.

Of the total product, 20,786,387 pounds, valued at $1,493,914, was credited to the vessel fisheries, and 14,674,241 pounds, valued at $776,945, to the shore or boat fisheries. In the vessel fisheries, gill nets and lines were employed and in the shore fisheries pound nets and trap nets, gill nets, fyke nets, seines, lines, and crawfish pots. The catch with these forms of apparatus was as follows: Gill nets, 22,346,654 pounds, valued at $1,458,809; pound nets and trap nets, 8,735,445 pounds, valued at $491,647; lines, 2,007,204 pounds, valued at $231,563; fyke nets, 1,906,613 pounds, valued at $72,875; seines, 384,217 pounds, valued at $11,538; crawfish pots, 80,495 pounds, valued at $4,427.

The products of the vessel and shore fisheries by States, counties, apparatus, and species in 1917 are shown in the following tables:

YIELD OF VESSEL FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES.

Apparatus and species.	Indiana.		Illinois.					
	Laporte.		Cook.		Lake.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Gill nets:								
Burbot	1,764	$75	58	$1			58	$1
Ciscoes, fresh	573,330	39,973	525,258	28,835	309,000	$15,935	834,258	44,770
Trout, lake	95,310	9,951	515	37	151,875	16,325	152,390	16,362
Whitefish, common, fresh.	100	15						
Yellow perch			44,613	3,807	34,200	1,875	78,813	5,682
Total	670,504	50,014	570,444	32,680	495,075	34,135	1,065,519	66,815
Lines: Trout, lake, fresh	7,000	700						
Grand total	677,504	50,714	570,444	32,680	495,075	34,135	1,065,519	66,815

Apparatus and species.	Michigan.							
	Benzie.		Berrien.		Charlevoix.		Delta.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Gill nets:								
Burbot	4,870	$89	2,770	$63	7,742	$172		
Ciscoes—								
Fresh	176,545	10,253	389,976	25,326	241,184	12,153	3,552	$125
Salted							34,840	1,398
Suckers	11,011	412	1,125	90	7,896	244	2,097	79
Trout, lake	295,695	26,896	233,164	24,163	876,740	54,663	96,499	7,720
Whitefish—								
Common, fresh	678,988	72,668	10,068	1,437	409,354	40,908	26,063	3,193
Common, salted					1,200	96		
Menominee, fresh	30	1			6,305	381		
Menominee, salted					100	7		
Yellow perch			1,725	202	14,908	892		
Total	1,167,139	110,319	638,828	51,281	1,565,429	109,516	163,051	12,515
Lines: Trout, lake, fresh					80,581	6,347		
Grand total	1,167,139	110,319	638,828	51,281	1,646,010	115,863	163,051	12,515

Apparatus and species.	Michigan—Continued.							
	Grand Traverse.		Leelanau.		Mackinac.		Manistee.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Gill nets:								
Burbot	1,100	$20						
Ciscoes, fresh	7,320	354	230,659	$11,985			75,405	$3,889
Suckers			250	10	13,309	$767	11,606	410
Trout, lake	12,000	884	378,500	27,722	32,969	3,044	139,542	14,051
Whitefish—								
Common, fresh	1,560	241	320,625	28,748	69,048	8,203	18,142	2,266
Common, salted					155	22		
Menominee, fresh					11,918	535		
Menominee, salted			698	47	5,900	442		
Yellow perch	987	86	36	3				
Total	22,967	1,585	930,768	68,515	133,299	13,013	244,695	20,616
Lines: Trout, lake, fresh					1,025	82	25,875	2,580
Grand total	22,967	1,585	930,768	68,515	134,324	13,095	270,570	23,196

YIELD OF VESSEL FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Michigan—Continued.							
	Mason.		Muskegon.		Oceana.		Ottawa.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Gill nets:								
Burbot	5,850	$169					1,522	$31
Ciscoes, fresh	167,110	11,363	20,555	$1,234	24,000	$1,440	863,050	48,878
Pike perch (wall-eyed or yellow pike)							40	6
Suckers	700	36	357	21				
Trout, lake	121,401	12,998	2,408	273	9,875	1,337	198,491	24,047
Whitefish, common, fresh	3,205	406	2,101	309	1,518	258	3,000	360
Yellow perch			4,942	396			1,000	70
Total	298,266	24,972	30,363	2,233	35,393	3,035	1,067,103	73,392
Lines: Trout, lake, fresh	27,465	3,530	13,466	1,526	36,575	5,676	38,981	5,021
Grand total	325,731	28,502	43,829	3,759	71,968	8,711	1,106,084	78,413

Apparatus and species.	Michigan—Continued.						Wisconsin.	
	Schoolcraft.		Van Buren.		Total.		Brown.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Gill nets:								
Burbot					23,854	$544	32,230	$161
Ciscoes—								
Fresh	13,891	$557	80,016	$5,303	2,293,263	132,860	573,702	18,645
Salted					34,840	1,398	43,138	2,027
Pike perch (wall-eyed or yellow pike)	114	23			154	29		
Suckers	5,747	287	542	52	54,640	2,408	1,624	49
Trout, lake	347,412	28,328	60,871	7,197	2,805,567	233,333		
Whitefish—								
Common, fresh	203,575	28,635	14,360	2,101	1,761,607	189,733		
Common, salted					1,355	118		
Menominee, fresh	2,875	115			21,128	1,032		
Menominee, salted					6,698	496		
Yellow perch			623	62	24,221	1,711	70,144	2,806
Total	573,614	57,945	156,412	14,715	7,027,327	563,662	720,838	23,688
Lines: Trout, lake, fresh					223,968	24,762		
Grand total	573,614	57,945	156,412	14,715	7,251,295	588,424	720,838	23,688

Apparatus and species.	Wisconsin—Continued.							
	Door.		Kenosha.		Kewaunee.		Manitowoc.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Gill nets:								
Burbot	43,664	$218						
Carp, Asiatic							1,300	$68
Ciscoes—								
Fresh	852,098	27,693	292,874	$16,084	265,573	$8,631	752,522	42,693
Salted	58,918	2,846						
Suckers	3,642	85			750	18	5,213	259
Trout, lake	285,784	29,722	180,346	19,616	41,723	4,339	152,772	13,800
Whitefish—								
Common, fresh	21,388	2,390					108	19
Menominee, fresh	23,145	926						
Yellow perch	38,851	1,554			15,312	612	10,928	951
Total	1,327,440	65,434	473,220	35,700	323,358	13,600	922,843	57,790
Lines:								
Pike	5,756	460						
Trout, lake—								
Fresh	300,888	31,292			410,525	42,695		
Salted					215	17		
Total	306,644	31,752			410,740	42,712		
Grand total	1,634,084	97,186	473,220	35,700	734,098	56,312	922,843	57,790

YIELD OF VESSEL FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Wisconsin—Continued.							
	Marinette.		Milwaukee.		Oconto.		Ozaukee.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Gill nets:								
Burbot	1,842	$9						
Ciscoes, fresh	1,868,107	65,372	965,870	$56,461	675,458	$21,952	309,680	$20,488
Pike	2,000	140						
Pike perch (wall-eyed or yellow pike)	700	84						
Suckers	166,218	7,849			6,089	142		
Trout, lake	99,528	8,808	1,029,581	105,051			177,128	18,600
Whitefish, common, fresh	21,056	2,176						
Yellow perch	68,114	2,725	71,360	5,224				
Total	2,227,565	87,163	2,066,811	166,736	681,547	22,094	486,808	39,088
Lines: Trout, lake, fresh							55,000	6,000
Grand total	2,227,565	87,163	2,066,811	166,736	681,547	22,094	541,808	45,088

Apparatus and species.	Wisconsin—Continued.						Grand total.	
	Racine.		Sheboygan.		Total.			
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Gill nets:								
Burbot					77,736	$388	103,412	$1,008
Carp, Asiatic					1,300	68	1,300	68
Ciscoes—								
Fresh	17,400	$1,000	600,430	$44,474	7,173,714	323,493	10,874,565	541,096
Salted					102,056	4,873	136,896	6,271
Pike					2,000	140	2,000	140
Pike perch (wall-eyed or yellow pike)					700	84	854	113
Suckers					183,536	8,402	238,176	10,810
Trout, lake	64,375	8,500	238,000	29,500	2,269,237	237,936	5,322,504	497,582
Whitefish—								
Common, fresh					42,502	4,585	1,804,209	194,333
Common, salted							1,355	118
Menominee, fresh					23,145	926	44,273	1,958
Menominee, salted							6,698	496
Yellow perch					274,709	13,872	377,743	21,265
Total	81,775	9,500	838,430	73,974	10,150,635	594,767	18,913,985	1,275,258
Lines:								
Pike					5,756	460	5,756	460
Trout, lake—								
Fresh	462,750	64,300	406,300	48,430	1,635,463	192,717	1,866,431	218,179
Salted					215	17	215	17
Total	462,750	64,300	406,300	48,430	1,641,434	193,194	1,872,402	218,656
Grand total	544,525	73,800	1,244,730	122,404	11,792,069	787,961	20,786,387	1,493,914

YIELD OF SHORE FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES.

Apparatus and species.	Michigan.									
	Allegan.		Antrim.		Benzie.		Berrien.		Charlevoix.	
	Lbs.	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*
Pound nets and trap nets:										
Burbot							100	$3	323	$8
Carp, Asiatic	300	$12					400	16		
Ciscoes, fresh	6,933	424	4,800	$282			63,984	3,616		
Pike perch (wall-eyed or yellow pike)	4,678	644					1,100	126		
Sheepshead or drum	1,600	64					300	12		
Sturgeon	795	179					1,720	443	40	5
Sturgeon caviar	16	32					190	570		
Suckers, fresh	4,249	186	3,250	208	10,000	$440	1,550	111		
Trout, lake, fresh	351	46	625	70			867	104	31,835	2,291
White bass	250	15								
Whitefish—										
Common, fresh	4,435	576	9,794	1,051	2,400	220	9,775	1,289	62,332	6,543
Menominee, fresh									865	49
Yellow perch, fresh	574	45			900	76	3,500	335	32,627	1,944
Total	24,181	2,223	18,469	1,611	13,300	736	83,486	6,625	128,022	10,840
Gill nets:										
Burbot									674	15
Ciscoes—										
Fresh	700	42	9,720	550	375	15	21,211	1,442	3,292	159
Salted	2,437	142								
Pike perch (wall-eyed or yellow pike)	80	11								
Sturgeon	100	26								
Suckers—										
Fresh	1,583	63			1,250	40	7,697	506	1,067	40
Salted									100	4
Trout, lake, fresh	665	93	2,565	270	31,250	2,500	16,158	2,391	74,542	5,492
Whitefish—										
Common, fresh	6,812	954	1,362	135	12,000	1,100	7,793	1,055	20,866	2,164
Menominee, fresh			240	18					12,398	760
Menominee, salted									7,300	546
Yellow perch	574	46			400	36	6,439	779	4,553	334
Total	12,951	1,377	13,887	973	45,275	3,691	59,298	6,173	124,792	9,514
Seines:										
Suckers							70	4		
Yellow perch							300	24		
Total							370	28		
Lines:										
Sturgeon							1,800	500		
Trout, lake			1,250	130						
Total			1,250	130			1,800	500		
Grand total	37,132	3,600	33,606	2,714	58,575	4,427	144,954	13,326	252,814	20,354

Yield of Shore Fisheries of Lake Michigan in 1917, by States, Counties, Apparatus, and Species—Continued.

Apparatus and species.	Michigan—Continued.									
	Delta.		Emmet.		Grand Traverse.		Leelanau.		Mackinac.	
Pound nets and trap nets:	*Pounds.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Pounds.*	*Value.*
Burbot	565	$7								
Ciscoes—										
Fresh	161,888	5,445			14,220	$965	27,038	$1,303	10,575	$370
Salted	46,341	1,576								
Pike perch (wall-eyed or yellow pike)	10,039	1,297	75	$9						
Sturgeon	763	94			35	3			890	124
Suckers, fresh	297,084	12,027	3,600	149	187,351	6,496	47,389	1,911	9,575	409
Trout, lake, fresh	16,985	1,557	11,225	985	7,174	594	35,845	2,743	36,448	2,780
Whitefish—										
Common, fresh	40,688	3,327	20,400	2,510	37,588	5,335	97,041	7,973	428,103	41,548
Common, salted									531	75
Menominee, fresh	823	42	3,000	210			114	9	7,589	478
Menominee, salted									1,600	115
Yellow perch, fresh	49,520	3,305			200	16	2,489	214		
Total	624,696	28,677	38,300	3,863	246,568	13,409	209,916	14,153	495,311	45,899
Gill nets:										
Ciscoes—										
Fresh	68,538	2,875	3,168	170	10,220	615	4,920	244		
Salted	33,148	1,536								
Pike	1,230	123								
Pike perch (wall-eyed or yellow pike)	17,027	2,093								
Suckers, fresh	221,061	9,813							11,042	521
Trout, lake—										
Fresh	25,180	2,262	80,173	6,051	8,500	785	15,867	1,348	15,005	1,355
Salted									200	22
Whitefish—										
Common, fresh	85,677	8,046	22,187	2,276	2,120	236	6,211	624	32,359	3,725
Common, salted									59	8
Menominee, fresh	949	53					1,308	82	3,726	252
Yellow perch	106,883	7,148	5,800	460	2,970	260	866	70	380	19
Total	559,693	33,949	111,328	8,957	23,810	1,896	29,172	2,368	62,771	5,902
Fyke nets:										
Ciscoes	2,120	84								
Pike	5,000	500								
Pike perch (wall-eyed or yellow pike)	29,168	3,035								
Suckers, fresh	57,092	2,678								
Yellow perch	19,801	1,582								
Total	113,181	7,879								
Lines: Trout, lake			5,000	420	6,375	604	4,375	400		
Grand total	1,297,570	70,505	154,628	13,240	276,753	15,909	243,463	16,921	558,082	51,801

YIELD OF SHORE FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Michigan—Continued.									
	Manistee.		Mason.		Menominee.		Muskegon.		Ottawa.	
Pound nets and trap nets:	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*
Burbot	......	......	1,000	$35	100	$1	200	$6	50	$1
Carp, Asiatic	......	......	130	5	......	......	410	16	600	23
Ciscoes—										
Fresh	7,688	$402	19,121	811	120,406	4,575	109,977	7,172	58,419	3,565
Salted	......	......	......	......	402,960	18,922	......	......	......	......
Pike	25	1	900	90	......	......	300	30	......	......
Pike perch (wall-eyed or yellow pike)	5,088	748	11,475	2,508	751	90	4,528	677	2,483	359
Sheepshead or drum	......	......	100	4	......	......	7,000	280	1,315	48
Sturgeon	158	35	48	10	361	72	434	104	360	108
Sturgeon caviar	......	......	......	......	......	......	50	125	25	62
Suckers, fresh	4,344	178	60,432	3,445	......	......	7,411	404	1,302	51
Trout, lake—										
Fresh	2,094	208	597	77	8,063	726	4,229	503	2,865	326
Salted	......	......	......	......	345	16	......	......	......	......
Trout, steelhead	......	......	......	......	......	......	500	81	......	......
White bass	......	......	......	......	......	......	350	35	......	......
Whitefish—										
Common, fresh	10,519	1,212	12,612	1,670	4,254	468	4,499	661	3,812	467
Menominee, fresh	......	......	......	......	49	4	......	......	......	......
Yellow perch—										
Fresh	4,945	191	3,513	391	3,461	136	650	55	4,040	210
Salted	......	......	......	......	1,725	81	......	......	......	......
Total	34,861	2,975	109,928	9,046	542,475	25,091	140,538	10,149	75,271	5,220
Gill nets:										
Burbot	......	......	......	......	200	2	......	......	......	......
Ciscoes, fresh	2,004	83	1,300	65	97,513	3,705	8,175	498	14,032	873
Pike	494	26	......	......	......	......	......	......	......	......
Pike perch (wall-eyed or yellow pike)	497	70	300	45	......	......	850	127	......	......
Sheepshead or drum	......	......	100	4	......	......	......	......	......	......
Sturgeon	785	109	20	6	......	......	......	......	......	......
Suckers—										
Fresh	13,431	590	1,000	50	3,754	150	6,640	391	......	......
Salted	......	......	......	......	345	16	......	......	......	......
Trout, lake, fresh	657	64	100	12	2,690	242	800	98	416	53
Trout, steelhead	......	......	......	......	......	......	200	36	......	......
Whitefish, common, fresh	691	80	500	75	......	......	1,015	144	50	5
Yellow perch	4,870	104	800	64	......	......	2,545	203	16,778	1,423
Total	23,429	1,126	4,120	321	104,502	4,115	20,225	1,497	31,276	2,354
Fyke nets:										
Pike	......	......	......	......	71	6	......	......	......	......
Pike perch (wall-eyed or yellow pike)	......	......	......	......	314	38	......	......	......	......
Yellow perch	......	......	......	......	1,100	44	......	......	......	......
Total	......	......	......	......	1,485	88	......	......	......	......
Lines: Yellow perch	......	......	700	56	......	......	......	......	......	......
Grand total	58,290	4,101	114,748	9,423	648,462	29,294	160,763	11,646	106,547	7,574

Yield of Shore Fisheries of Lake Michigan in 1917, by States, Counties, Apparatus, and Species—Continued.

Apparatus and species.	Michigan—Continued.						Indiana.			
	Schoolcraft.		Van Buren.		Total.		Lake.		Laporte.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Pound nets and trap nets:										
Burbot					2,338	$61	125	$3	400	$32
Carp, Asiatic					1,840	72	409	16	650	26
Catfish and bullheads									120	17
Ciscoes—										
Fresh					605,049	28,930	65,000	3,800	59,000	2,840
Salted					449,301	20,498				
Pike					1,225	121			175	26
Pike perch (wall-eyed or yellow pike)	400	$80			40,617	6,538			1,400	240
Sheepshead or drum					10,315	408			750	30
Sturgeon					5,604	1,177	914	256	482	162
Sturgeon caviar					281	789	40	70	10	15
Suckers—										
Fresh	15,600	1,031			653,137	27,046	540	22	1,500	60
Salted	2,100	74			2,100	74				
Trout, lake—										
Fresh	16,162	1,274			175,365	14,284	100	10	600	84
Salted					345	16				
Trout, steelhead					500	81	200	30	900	180
White bass					600	50				
Whitefish—										
Common, fresh	107,427	10,842			855,679	85,692	300	42	3,300	595
Common, salted					531	75				
Menominee, fresh	15,250	610			27,690	1,402				
Menominee, salted	9,700	776			11,300	891				
Yellow perch—										
Fresh					106,419	6,918	6,300	565	6,500	605
Salted					1,725	81				
Total	166,639	14,687			2,951,961	195,204	73,919	4,814	75,787	4,912
Gill nets:										
Burbot					874	17	500	10		
Ciscoes—										
Fresh	12,335	514	1,200	$86	258,703	11,936	21,500	1,285	9,400	540
Salted					35,585	1,678				
Pike					1,724	149				
Pike perch (wall-eyed or yellow pike)	9	1			18,763	2,347				
Sheepshead or drum					100	4				
Sturgeon	50	6	50	13	1,005	160				
Suckers—										
Fresh	2,438	97	900	48	271,863	12,309	200	8	500	20
Salted					445	20				
Trout, lake—										
Fresh	15,390	1,203	2,400	284	292,358	24,503	19,000	2,340	100	11
Salted					200	22				
Trout, steelhead					200	36	19,000	2,850		
Whitefish—										
Common, fresh	12,939	1,348	10,000	1,202	222,582	23,169			150	27
Common, salted					59	8				
Menominee, fresh	9,248	277			27,869	1,442				
Menominee, salted					7,300	546				
Yellow perch			3,200	276	157,058	11,222	12,000	1,220	12,100	1,036
Total	52,409	3,446	17,750	1,909	1,296,688	89,568	72,200	7,713	22,250	1,634
Fyke nets:										
Ciscoes					2,120	84				
Pike					5,071	506				
Pike perch (wall-eyed or yellow pike)					29,482	3,073				
Suckers, fresh					57,092	2,678				
Yellow perch					20,901	1,626				
Total					114,666	7,967				

Yield of Shore Fisheries of Lake Michigan in 1917, by States, Counties, Apparatus, and Species—Continued.

Apparatus and species.	Michigan—Continued.						Indiana.			
	Schoolcraft.		Van Buren.		Total.		Lake.		Laporte.	
	Lbs.	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*
Seines:										
Suckers					70	$4				
Yellow perch					300	24				
Total					370	28				
Lines:										
Sturgeon					1,800	500	600	$150		
Sturgeon caviar							15	30		
Trout, lake					17,000	1,554				
Yellow perch					700	56				
Total					19,500	2,110	615	180		
Grand total	219,048	$18,133	17,750	$1,909	4,383,185	294,877	146,734	12,707	98,037	$6,546

Apparatus and species.	Indiana—Continued.				Illinois.					
	Porter.		Total.		Cook.		Lake.		Total.	
	Lbs.	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*
Pound nets and trap nets:										
Burbot	150	$6	675	$41						
Carp, Asiatic	100	4	1,150	46						
Catfish and bullheads			120	17						
Ciscoes, fresh	80,000	4,000	204,000	10,640			9,600	$555	9,600	$555
Pike	50	4	225	30						
Pike perch (wall-eyed or yellow pike)			1,400	240						
Sheepshead or drum			750	30						
Sturgeon	400	112	1,796	530						
Sturgeon caviar			50	85						
Suckers, fresh	400	20	2,440	102			5,265	200	5,265	200
Trout, lake, fresh	1,300	130	2,000	224			16,250	1,750	16,250	1,750
Trout, steelhead	1,075	161	2,175	371						
Whitefish, common, fresh	250	36	3,850	673			33,600	4,750	33,600	4,750
Yellow perch, fresh	1,500	150	14,300	1,320			2,100	125	2,100	125
Total	85,225	4,623	234,931	14,349			66,815	7,380	66,815	7,380
Gill nets:										
Burbot	200	4	700	14						
Ciscoes, fresh	5,600	275	36,500	2,100	54,840	$2,990	117,120	5,825	171,960	8,815
Suckers, fresh	50	2	750	30						
Trout, lake, fresh			19,100	2,351						
Trout, steelhead	75	11	19,075	2,861						
Whitefish, common, fresh	50	7	200	34						
Yellow perch	2,700	210	26,800	2,466	20,000	1,350	16,000	1,015	36,000	2,365
Total	8,675	509	103,125	9,856	74,840	4,340	133,120	6,840	207,960	11,180
Lines:										
Sturgeon			600	150						
Sturgeon caviar			15	30						
Yellow perch					16,000	2,000			16,000	2,000
Total			615	180	16,000	2,000			16,000	2,000
Grand total	93,900	5,132	338,671	24,385	90,840	6,340	199,935	14,220	290,775	20,560

YIELD OF SHORE FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Wisconsin.									
	Brown.		Door.		Kenosha.		Kewaunee.		Manitowoc.	
Pound nets and trap nets:	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*
Burbot	8,500	$43	2,530	$13						
Catfish and bullheads	600	24								
Ciscoes—										
Fresh	123,930	4,028	543,111	17,651			157,443	$5,117		
Salted			1,717,403	82,951						
Pike	600	48	3,216	257						
Pike perch (wall-eyed or yellow pike)	300	45								
Rock bass			1,714	137						
Sheepshead or drum	1,920	38								
Suckers—										
Fresh	538	13	48,176	1,930			3,112	75		
Salted			8,160	371						
Trout, lake—										
Fresh			121,531	11,667			1,238	119	298,198	$27,611
Salted			1,830	186						
Whitefish—										
Common, fresh	600	67	26,664	2,560			1,000	112	41,274	4,302
Menominee, salted			805	40						
Yellow perch, fresh	11,223	449	36,752	1,470			2,520	101	740	69
Total	148,211	4,755	2,511,892	119,233			165,313	5,524	340,212	31,982
Gill nets:										
Burbot	28,237	141								
Carp, Asiatic									500	23
Ciscoes—										
Fresh	380,801	12,376	200,524	6,517					3,240	162
Salted	15,222	735	12,229	591						
Pike perch (wall-eyed or yellow pike)	1,914	287	662	99						
Sheepshead or drum			318	16						
Suckers, fresh	2,142	50	12,817	308					7,300	295
Trout, lake, fresh			70,196	6,739					1,250	135
Yellow perch	210,432	8,417	50,214	2,009	6,360	$474			4,300	360
Total	638,748	22,006	346,960	16,279	6,360	474			16,590	975
Fyke nets:										
Burbot	17,919	90								
Carp, Asiatic	27,464	824								
Catfish and bullheads	147,977	5,955								
Pike	2,918	233								
Pike perch (wall-eyed or yellow pike)	16,075	2,411								
Sheepshead or drum	15,009	300								
Suckers—										
Fresh	483,993	11,293								
Salted	2,600	122								
White bass	675	27								
Yellow perch	824,904	32,996								
Total	1,539,534	54,251								
Seines:										
Carp, Asiatic	185,989	5,580							960	50
Suckers	49,473	1,154							6,250	245
Whitefish									1,200	130
Yellow perch	5,600	224								
Total	241,062	6,958							8,410	425
Lines:										
Trout, lake			24,120	2,316			8,327	799		
Yellow perch			9,415	377						
Total			33,535	2,693			8,327	799		
Crawfish pots: Crawfish	80,495	4,427								
Grand total	2,648,050	92,397	2,892,387	138,205	6,360	474	173,640	6,323	365,212	33,382

YIELD OF SHORE FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Wisconsin—Continued.									
	Marinette.		Milwaukee.		Oconto.		Ozaukee.		Racine.	
	Lbs.	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*
Pound nets and trap nets:										
Carp, Asiatic			200	$12	100	$3				
Catfish and bullheads	3,969	$159			1,800	72				
Ciscoes—										
Fresh	305,732	7,643	4,800	235	428,342	13,921	30,000	$1,200		
Salted	317,135	15,318			233,995	11,302				
Pike					4,000	320				
Pike perch (wall-eyed or yellow pike)	276	41			4,441	666				
Suckers—										
Fresh	18,320	427	900	45	32,944	769	900	42		
Salted					805	38				
Trout, lake—										
Fresh	25,461	2,648	625	76	15,144	1,575	20,000	1,700		
Salted					230	18				
Whitefish, common, fresh	3,778	423	4,680	571	14,344	1,607	5,040	545		
Yellow perch, fresh	24,510	980	8,000	650	201,680	8,067	800	68		
Total	699,181	27,639	19,205	1,589	937,825	38,358	56,740	3,555		
Gill nets:										
Burbot					1,600	8				
Ciscoes, fresh	222,409	5,560	98,640	4,724	342,131	11,119	2,460	105	3,000	$150
Suckers, fresh	19,716	460	1,205	43	4,992	116	1,900	89		
Trout, lake, fresh	9,701	1,009	41,250	5,000						
Whitefish, common, fresh	1,838	206								
Yellow perch	9,896	396	38,000	3,100	2,600	104	1,700	127	3,500	270
Total	263,560	7,631	179,095	12,867	351,323	11,347	6,060	321	6,500	420
Fyke nets:										
Carp, Asiatic					400	12				
Catfish and bullheads					10,000	400				
Pike	4,562	365			9,100	728				
Pike perch (wall-eyed or yellow pike)	642	96			10,823	1,623				
Suckers, fresh	8,645	202			65,887	1,537				
Yellow perch	7,901	316			134,453	5,378				
Total	21,750	979			230,663	9,678				
Seines:										
Carp, Asiatic					26,000	780				
Pike perch (wall-eyed or yellow pike)					5,575	866				
Suckers					100,000	2,333				
Total					131,775	3,979				
Lines:										
Trout, lake			4,375	550			50,000	4,400		
Yellow perch									2,450	175
Total			4,375	550			50,000	4,400	2,450	175
Grand total	984,491	36,249	202,675	15,006	1,651,586	63,362	112,800	8,276	8,950	595

YIELD OF SHORE FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Wisconsin—Continued.				Grand total.	
	Sheboygan.		Total.			
	Lbs.	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*
Pound nets and trap nets:						
Burbot			11,030	$56	14,043	$158
Carp, Asiatic			300	15	3,290	133
Catfish and bullheads			6,369	255	6,489	272
Ciscoes—						
Fresh	332,528	$11,974	1,925,886	61,769	2,744,535	101,894
Salted			2,268,533	109,571	2,717,834	130,069
Pike			7,816	625	9,266	776
Pike perch (wall-eyed or yellow pike)			5,017	752	47,034	7,530
Rock bass			1,714	137	1,714	137
Sheepshead or drum			1,920	38	12,985	476
Sturgeon					7,400	1,707
Sturgeon caviar					331	874
Suckers—						
Fresh	150	4	105,040	3,305	765,882	30,653
Salted			8,965	409	11,065	483
Trout, lake—						
Fresh	245,471	26,108	727,668	71,504	921,283	87,762
Salted			2,060	204	2,405	220
Trout, steelhead					2,675	452
White bass					600	50
Whitefish—						
Common, fresh	24,910	3,988	122,290	14,175	1,015,419	105,290
Common, salted					531	75
Menominee, fresh					27,690	1,402
Menominee, salted			805	40	12,105	931
Yellow perch—						
Fresh	100	5	286,325	11,859	409,144	20,222
Salted					1,725	81
Total	603,159	42,079	5,481,738	274,714	8,735,445	491,647
Gill nets:						
Burbot			29,837	149	31,411	180
Carp, Asiatic			500	23	500	23
Ciscoes—						
Fresh			1,253,205	40,713	1,720,368	63,564
Salted			27,451	1,326	63,036	3,004
Pike					1,724	149
Pike perch (wall-eyed or yellow pike)			2,576	386	21,339	2,733
Sheepshead or drum			318	16	418	20
Sturgeon					1,005	160
Suckers—						
Fresh	4,700	175	54,772	1,536	327,385	13,875
Salted					445	20
Trout, lake—						
Fresh			122,397	12,883	433,855	39,737
Salted					200	22
Trout, steelhead					19,275	2,897
Whitefish—						
Common, fresh			1,838	206	224,620	23,409
Common, salted					59	8
Menominee, fresh	500	27	500	27	28,369	1,469
Menominee, salted					7,300	546
Yellow perch	4,500	425	331,502	15,682	551,360	31,735
Total	9,700	627	1,824,896	72,947	3,432,669	183,551
Fyke nets:						
Burbot			17,919	90	17,919	90
Carp, Asiatic			27,864	836	27,864	836
Catfish and bullheads			157,977	6,355	157,977	6,355
Ciscoes					2,120	84
Pike			16,580	1,326	21,651	1,832
Pike perch (wall-eyed or yellow pike)			27,540	4,130	57,022	7,203
Sheepshead or drum			15,009	300	15,009	300
Suckers—						
Fresh			558,525	13,032	615,617	15,710
Salted			2,600	122	2,600	122
White bass			675	27	675	27
Yellow perch			967,258	38,690	988,159	40,316
Total			1,791,947	64,908	1,906,613	72,875

YIELD OF SHORE FISHERIES OF LAKE MICHIGAN IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Wisconsin—Continued.				Grand total.	
	Sheboygan.		Total.			
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Seines:						
Carp, Asiatic	600	$30	213,549	$6,440	213,549	$6,440
Pike	200	18	200	18	200	18
Pike perch (wall-eyed or yellow pike)			5,775	866	5,775	866
Suckers	1,600	75	157,323	3,807	157,393	3,811
Whitefish			1,200	130	1,200	130
Yellow perch	200	25	5,800	249	6,100	273
Total	2,600	148	383,847	11,510	384,217	11,538
Lines:						
Sturgeon					2,400	650
Sturgeon caviar					15	30
Trout, lake			86,822	8,065	103,822	9,619
Yellow perch			11,865	552	28,565	2,608
Total			98,687	8,617	134,802	12,907
Crawfish pots: Crawfish			80,495	4,427	80,495	4,427
Grand total	615,459	42,854	9,661,340	437,123	14,674,241	776,945

WHOLESALE FISHERY TRADE.

The wholesale fishery trade of Lake Michigan in 1917 was carried on by 75 establishments, of which 38 were in Chicago, 7 in Green Bay, and the same number in Milwaukee, the principal centers of the wholesale trade, and the remaining 22 distributed in Michigan and Wisconsin towns. The number of persons employed was 752, to whom $792,927 were paid in wages; the value of the shore and accessory property utilized was $1,444,826; and the cash capital amounted to $349,800.

The following table shows the extent of the wholesale fishery trade of Lake Michigan in 1917:

WHOLESALE FISHERY TRADE OF LAKE MICHIGAN IN 1917.

Cities and towns.	State.	Number of firms.	Persons engaged.	Wages paid.	Shore and accessory property.	Cash capital.
Chicago [1]	Illinois	39	485	$624,821	$1,082,919	$113,500
Grand Haven, Charlevoix, and St. Joseph.	Michigan	5	24	27,178	40,105	41,000
Escanaba, Fairport, Manistique, and Naubinway.	do	4	10	3,460	7,300	6,000
Menominee	do	3	36	18,100	65,961	80,000
Green Bay	Wisconsin	7	107	82,504	153,694	79,500
Sturgeon Bay, Detroit Harbor, and Two Rivers.	do	4	18	6,564	15,710	8,300
Marinette	do	3	32	14,700	16,687	9,000
Milwaukee	do	7	26	10,900	58,000	10,000
Port Washington and Sheboygan.	do	3	14	4,700	4,450	2,500
Total		75	752	792,927	1,444,826	349,800

[1] Includes one firm at Michigan City, Ind.

FISHERIES OF LAKE HURON.

The total number of persons employed in the fisheries of Lake Huron in 1917 was 1,348. Of this number, 149 were on fishing vessels, 29 on transporting vessels, 1,023 in the shore or boat fisheries, and 147 shoresmen in the wholesale establishments and other shore activities.

The total investment in the fisheries amounted to $1,188,705, which included 26 steam and gasoline fishing vessels of 379 net tons, valued at $76,500, and their outfits valued at $27,990; 21 transporting vessels of 193 net tons, valued at $40,500, and outfits valued at $5,250; 570 boats valued at $111,980; fishing apparatus used in the vessel fisheries to the value of $73,419 and in the shore or boat fisheries to the value of $264,874; shore and accessory property with a value of $432,092; and cash capital amounting to $156,100. Gill nets and lines were employed in both vessel and shore fisheries. The number of gill nets used in the vessel fisheries was 6,613, representing a value of $69,575, and in the boat fisheries 3,997, valued at $33,260, a total of 10,610 nets with a value of $102,835. The use of pound nets, trap nets, fyke nets, seines, and spears was confined to the shore fisheries. The number of pound nets and trap nets operated was 1,731, valued at $207,904.

The products of the fisheries of Lake Huron in 1917 aggregated 13,363,207 pounds, valued at $857,478. The more important species were ciscoes, 5,381,365 pounds, valued at $215,782; lake trout, 2,079,455 pounds, valued at $214,574; suckers, 1,776,767 pounds, valued at $72,933; carp, 1,145,250 pounds, valued at $43,474; common whitefish, 998,226 pounds, valued at $124,637; pike perch, 994,672 pounds, valued at $119,234; and yellow perch, 844,019 pounds, valued at $56,464.

In comparison with the other lakes in 1917 Lake Huron ranked third in the number of persons engaged, investment, and value of the products and fourth in the quantity of products taken. Compared with 1903 there has been a decrease of 356, or 20.89 per cent, in the number of persons engaged; an incease of $337,066, or 39.57 per cent, in the investment and $407,160, or 90.42 per cent, in the value of the products; and a decrease of 1,092,002 pounds, or 7.55 per cent, in the quantity of the products.

FISHERIES, BY COUNTIES.

The number of persons engaged, investment, and quantity and value of the products of the fisheries in 1917, by counties, are shown in the following tables:

STATISTICS OF THE FISHERIES OF LAKE HURON IN 1917, BY COUNTIES.

PERSONS ENGAGED.

County.	On vessels fishing.	On vessels transporting.	In shore or boat fisheries.	Shoresmen.	Total.
Alcona			20		20
Alpena	54	1	66	14	135
Arenac			91		91
Bay		2	220	46	268
Cheboygan	19	12	73	8	112
Chippewa	5	6	49	4	64
Huron	38	2	246	52	338
Iosco	9		67	11	87
Mackinac		5	89	4	98
Presque Isle	24		20	5	49
St. Clair		1	18	3	22
Sanilac			42		42
Tuscola			22		22
Total	149	29	1,023	147	1,348

STATISTICS OF THE FISHERIES OF LAKE HURON IN 1917, BY COUNTIES—Continued.

INVESTMENT.

Items.	Alcona.		Alpena.		Arenac.		Bay.		Cheboygan.	
	Number.	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
Vessels, fishing:										
Steam			6	$29,500					1	$2,500
Tonnage			154						9	
Outfit				12,650						1,400
Gasoline			1	3,000					4	5,500
Tonnage			8						35	
Outfit				250						1,530
Vessels transporting:										
Steam									1	5,500
Tonnage									13	
Outfit										300
Gasoline			1	1,000			1	$2,800	9	15,700
Tonnage			10				9		78	
Outfit				100				475		2,010
Sail and rowboats	8	$240	32	695	13	$345	51	1,465	29	840
Power boats	5	975	16	2,860	14	3,450	44	16,900	15	4,675
Apparatus, vessel fisheries:										
Gill nets			2,758	31,460					1,130	10,215
Lines				800						
Apparatus, shore fisheries:										
Pound nets and trap nets	39	2,750	108	8,385	81	19,856	240	33,330	276	12,825
Gill nets	70	600	223	1,542	6	60	69	700	455	4,490
Fyke nets					10	400	122	4,325		
Seines					11	1,470	27	3,125		
Lines		50								
Spears					25	200	90	720		
Shore and accessory property		4,000		37,825		17,250		115,672		16,125
Cash capital				37,000				41,500		20,000
Total		8,615		167,067		43,031		221,012		103,610

Items.	Chippewa.		Huron.		Iosco.		Mackinac.		Presque Isle.	
	Number.	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
Vessels, fishing:										
Steam	1	$2,000	4	$22,500	1	$1,000				
Tonnage	9		80		14					
Outfit		400		6,200		1,800				
Gasoline			2	3,600	1	700			5	$6,200
Tonnage			22		8				40	
Outfit				700						3,060
Vessels transporting:										
Steam							1	$1,500		
Tonnage							11			
Outfit								200		
Gasoline	3	6,700	1	1,500			3	3,300		
Tonnage	28		7				30			
Outfit		935		400				530		
Sail and rowboats	20	415	74	2,000	15	385	38	855	13	300
Power boats	16	7,700	68	31,625	23	12,900	28	11,925	4	900
Apparatus, vessel fisheries:										
Gill nets	100	1,000	1,330	12,800	300	2,600			995	11,500
Lines				2,344		300				400
Apparatus, shore fisheries:										
Pound nets and trap nets	184	9,150	397	65,383	75	18,850	223	15,395	22	1,480
Gill nets	743	5,522	588	4,384	819	7,956	579	4,064	74	702
Fyke nets			309	6,830	9	450				
Seines			30	2,915	4	180				
Lines				1,435		165		80		100
Spears			75	600						
Shore and accessory property		10,750		147,432		28,050		9,630		10,150
Cash capital		2,000		25,600		10,000		10,000		5,000
Total		42,572		338,248		85,336		57,479		39,792

STATISTICS OF THE FISHERIES OF LAKE HURON IN 1917, BY COUNTIES—Continued.

INVESTMENT—Continued.

Items.	St. Clair.		Sanilac.		Tuscola.		Total.	
	Number.	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
Vessels fishing:								
Steam							13	$57,500
Tonnage							266	
Outfit								22,450
Gasoline							13	19,000
Tonnage							113	
Outfit								5,540
Vessels transporting:								
Steam							2	7,000
Tonnage							24	
Outfit								500
Gasoline	1	$2,500					19	33,500
Tonnage	7						169	
Outfit		300						4,750
Sail and rowboats	3	95	9	$220	5	$165	310	8,020
Power boats	6	1,200	15	6,900	6	1,950	260	103,960
Apparatus, vessel fisheries:								
Gill nets							6,613	69,575
Lines								3,844
Apparatus, shore fisheries:								
Pound nets and trap nets	13	2,300	42	14,400	31	3,800	1,731	207,904
Gill nets	90	265	281	2,975			3,997	33,260
Fyke nets					10	130	460	12,135
Seines					5	270	77	7,960
Lines		100		135		30		2,095
Spears							190	1,520
Shore and accessory property		11,153		18,555		5,500		432,092
Cash capital		5,000						156,100
Total		22,913		43,185		11,845		1,188,705

YIELD, BY SPECIES.

Species.	Alcona.		Alpena.		Arenac.		Bay.		Cheboygan.	
	Lbs.	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*
Bowfin					200	$4				
Burbot							200	$4	350	$7
Carp, Asiatic					15,008	636	219,105	8,297	850	34
Catfish and bullheads			21	$1	850	62	13,538	1,245	450	22
Ciscoes:										
Fresh	182,050	$5,390	395,366	27,297	168,594	4,695	345,762	5,919	44,499	2,333
Salted			2,480	105	174,855	9,242	207,585	9,341		
Smoked			3,000	120						
Muskellunge			45	5						
Pike	300	32	510	47	100	10	1,150	97	925	76
Pike perch (wall-eyed or yellow pike), fresh	7,100	855	12,622	2,238	51,059	5,337	283,199	29,903	24,857	2,497
Rock bass					300	12	800	48	833	34
Sheepshead or drum					300	12	600	18		
Sturgeon	193	25	665	133	70	21	200	50	260	59
Sturgeon caviar			23	46			12	24		
Suckers, fresh	37,825	1,497	118,458	6,202	59,131	1,806	413,447	12,221	377,751	15,686
Sunfish					300	12	800	32		
Trout, lake:										
Fresh	16,850	1,737	509,995	60,392	140	14	2,400	244	136,515	13,616
Salted			4,475	448						
Whitefish:										
Common, fresh	2,600	349	188,512	26,620	21,255	2,691	45,877	4,649	162,662	19,940
Common, salted			850	130						
Common, caviar							300	60		
Menominee, fresh	11,200	279	15,691	694					5,605	372
Menominee, salted			1,800	90					14,417	787
Yellow perch	2,000	150	10,312	1,020	60,182	3,636	444,511	26,384	20,856	1,482
Total	260,118	10,314	1,264,825	125,588	552,344	28,190	1,979,486	98,536	790,830	56,945

STATISTICS OF THE FISHERIES OF LAKE HURON IN 1917, BY COUNTIES—Continued.

YIELD, BY SPECIES—Continued.

Species.	Chippewa.		Huron.		Iosco.		Mackinac.		Presque Isle.	
	Lbs.	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*
Bowfin										
Burbot					824	$24	800	$16		
Carp, Asiatic			861,976	$32,574	200	8				
Catfish and bullheads	1,077	$178	14,493	1,505	300	30				
Ciscoes:										
Fresh	101,300	5,065	747,798	26,180	492,389	12,857	10,200	414	275,481	$15,173
Salted			1,243,019	53,355	125,700	7,542	61,000	2,495		
Muskellunge	100	10								
Pike	6,000	600	2,419	241	200	16	750	56		
Pike perch (wall-eyed or yellow pike):										
Fresh	29,998	4,280	374,691	51,908	117,816	11,424	3,092	339	1,050	113
Salted									30	3
Rock bass	2,000	100								
Sheepshead or drum			5,850	176						
Sturgeon			930	187	650	160	240	49		
Sturgeon caviar					20	40	20	50		
Suckers:										
Fresh	241,712	13,609	130,096	3,953	46,322	1,870	291,896	13,782	28,777	1,161
Salted							1,000	50		
Sunfish	200	10								
Trout, lake:										
Fresh	146,667	12,348	582,708	61,891	433,000	38,424	87,933	9,341	97,977	9,831
Salted	900	90	2,235	90			1,000	150	48	6
Whitefish:										
Common, fresh	17,113	1,883	184,784	21,624	159,011	17,558	141,371	19,030	30,922	3,816
Common, salted							2,500	200		
Common, caviar			1,075	197						
Menominee, fresh	650	52			136	6	9,475	513	3,700	275
Menominee, salted							3,800	323		
Yellow perch	24,371	2,225	178,184	13,226	8,695	617	55,183	4,348	200	19
Total	572,088	40,450	4,330,258	267,107	1,385,263	90,576	670,260	51,156	438,185	30,397

Species.	St. Clair.		Sanilac.		Tuscola.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Bowfin							200	$4
Burbot							2,174	51
Carp, Asiatic			1,800	$72	46,311	$1,853	1,145,250	43,474
Catfish and bullheads			200	16	2,400	236	33,329	3,295
Ciscoes:								
Fresh	45,914	$1,289	443,257	13,298	24,963	795	3,277,573	120,705
Salted			286,053	12,873	100	4	2,100,792	94,957
Smoked							3,000	120
Muskellunge							145	15
Pike							12,354	1,175
Pike perch (wall-eyed or yellow pike):								
Fresh	26,320	3,980	19,010	2,594	43,828	3,763	991,642	119,231
Salted							30	3
Rock bass			50	2	300	12	4,283	208
Sheepshead or drum	10,181	382	200	6	600	21	17,731	615
Sturgeon	1,218	287	460	92			4,886	1,063
Sturgeon caviar	122	268	30	67			227	495
Suckers:								
Fresh	6,481	426	4,404	168	19,467	502	1,775,767	72,883
Salted							1,000	50
Sunfish			50	2	300	12	1,650	68
Trout, lake:								
Fresh	1,242	143	42,429	4,515			2,070,797	213,790
Salted							8,658	784
Whitefish:								
Common, fresh	2,107	296	37,014	5,556	273	38	993,501	124,050
Common, salted							3,350	330
Common, caviar							1,375	257
Menominee, fresh							46,457	2,191
Menominee, salted							20,017	1,200
Yellow perch	731	74	6,958	972	31,836	2,311	844,019	56,464
Total	94,316	7,145	841,915	40,233	170,378	9,547	13,363,207	857,478

FISHERIES, BY APPARATUS.

The vessel fisheries of Lake Huron in 1917 were credited with 2,675,783 pounds, valued at $258,297, and the shore or boat fisheries with 10,687,424 pounds, valued at $599,181. In the vessel fisheries, the principal form of apparatus was the gill net, the catch of all species amounting to 2,350,721 pounds, with a value of $224,787. The principal species were lake trout, 1,094,301 pounds, valued at $116,925; ciscoes, 826,537 pounds, valued at $53,125; and common whitefish, 410,475 pounds, valued at $53,716. The catch with lines, consisting of lake trout, was 325,062 pounds, valued at $33,510.

The principal apparatus of capture used in the shore or boat fisheries was pound nets and trap nets, the catch amounting to 7,936,249 pounds, consisting principally of ciscoes, pike perch, suckers, common whitefish, and yellow perch, valued at $420,409. The catch with other forms of apparatus in the shore fisheries was as follows: Gill nets, 994,759 pounds, principally ciscoes, lake trout, and common whitefish, valued at $88,257; seines, 1,306,502 pounds, principally carp, valued at $56,474; fyke nets, 263,999 pounds, principally yellow perch, suckers, carp, and pike perch, valued at $14,108; lines, 106,655 pounds, consisting of catfish, lake trout, common whitefish, and yellow perch, valued at $10,644; and spears, 79,260 pounds, consisting of carp, pike, pike perch, lake trout, and yellow perch, valued at $9,289. The total catch with gill nets in both vessels and shore fisheries amounted to 3,345,480 pounds, valued at $313,044, and with lines, 431,717 pounds, valued at $44,154.

The following tables give the products of the vessel and shore fisheries of Lake Huron in 1917:

YIELD OF VESSEL FISHERIES OF LAKE HURON IN 1917, BY COUNTIES AND APPARATUS.

Apparatus and species.	Alpena.		Cheboygan.		Chippewa.		Huron.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Gill nets:								
Burbot			300	$6				
Carp, Asiatic							75	$3
Ciscoes	314,232	$24,074	29,704	1,492	54,000	$2,700	162,420	9,978
Pike perch (wall-eyed or yellow pike)	1,000	91	155	19			206	36
Sturgeon			60	15				
Suckers							100	2
Trout, lake	489,041	58,220	72,187	7,192	15,000	1,500	192,354	21,983
Whitefish—								
Common	165,463	23,762	89,345	11,027			82,755	10,536
Menominee	8,460	338	750	35				
Yellow perch			221	27			1,571	188
Total	978,196	106,485	192,722	19,813	69,000	4,200	439,481	42,726
Lines:								
Trout, lake—								
Fresh	4,500	450					292,193	30,518
Salted							2,235	90
Total	4,500	450					294,428	30,608
Grand total	982,696	106,935	192,722	19,813	69,000	4,200	733,909	73,334

YIELD OF VESSEL FISHERIES OF LAKE HURON IN 1917, BY COUNTIES AND APPARATUS—Continued.

Apparatus and species.	Iosco.		Presque Isle.		Total.	
	Lbs.	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*
Gill nets:						
Burbot					300	$6
Carp, Asiatic					75	3
Ciscoes			266,181	$14,881	826,537	53,125
Pike perch (wall-eyed or yellow pike)	2,160	$173			3,521	319
Sturgeon					60	15
Suckers	3,250	33			3,350	35
Trout, lake	236,450	18,916	76,328	7,820	1,094,301	116,925
Whitefish—						
Common	45,650	5,021	27,262	3,370	410,475	53,716
Menominee			1,100	55	10,310	428
Yellow perch					1,792	215
Total	287,510	24,143	370,871	26,126	2,350,721	224,787
Lines:						
Trout, lake—						
Fresh	10,000	1,000	16,134	1,452	322,827	33,420
Salted					2,235	90
Total	10,000	1,000	16,134	1,452	325,062	33,510
Grand total	297,510	25,143	387,005	27,578	2,675,783	258,297

YIELD OF THE SHORE FISHERIES OF LAKE HURON IN 1917, BY COUNTIES AND APPARATUS.

Apparatus and species.	Alcona.		Alpena.		Arenac.		Bay.		Cheboygan.	
	Lbs.	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*
Pound nets and trap nets:										
Burbot							200	$4	50	$1
Carp, Asiatic					2,927	$138	19,871	720	850	34
Catfish and bullheads			21	$1			6,300	564	450	22
Ciscoes—										
Fresh	181,550	$5,360	69,934	2,715	168,594	4,695	339,262	5,644	7,295	360
Salted			300	12	174,855	9,242	207,585	9,341		
Muskellunge			45	5						
Pike	300	32	510	47			450	37	825	66
Pike perch (wall-eyed or yellow pike)	7,100	855	11,510	2,136	19,444	2,036	172,850	17,699	24,702	2,478
Rock bass					300	12	200	8	833	34
Sheepshead or drum					300	12	600	18		
Sturgeon	193	25	665	133	70	21	200	50	200	44
Sturgeon caviar			23	46			12	24		
Suckers, fresh	37,825	1,497	115,558	6,115	15,130	469	292,716	9,165	369,588	15,317
Sunfish					300	12	400	16		
Trout, lake	1,300	170	8,369	938	140	14	2,400	244	1,600	160
Whitefish—										
Common	1,200	169	23,049	2,858	21,255	2,691	45,165	4,541	36,545	4,367
Common caviar							300	60		
Menominee	11,100	269							529	25
Yellow perch	2,000	150	8,812	910	48,989	2,980	360,432	20,934	13,073	924
Total	242,568	8,527	238,796	15,916	452,304	22,322	1,448,943	69,069	456,540	23,832
Gill nets:										
Bowfin					200	4				
Carp, Asiatic					400	16				
Catfish and bullheads					150	6				
Ciscoes—										
Fresh	500	30	11,200	508					7,500	481
Salted			2,180	93						
Smoked			3,000	120						
Pike									100	10
Pike perch (wall-eyed or yellow pike, fresh			112	11	400	40				
Suckers			2,900	87	1,000	20	2,000	40	8,163	369
Trout, lake—										
Fresh	15,200	1,525	8,085	784					62,728	6,264
Salted			4,475	448						
Whitefish—										
Common, fresh	1,400	180							36,772	4,546
Common, salted			850	130						
Menominee, fresh	100	10	7,231	356					4,326	312
Menominee, salted			1,800	90					14,417	787
Yellow perch			1,500	110	250	18	6,000	550	7,562	531
Total	17,200	1,745	43,333	2,737	2,400	104	8,000	590	141,568	13,300

YIELD OF THE SHORE FISHERIES OF LAKE HURON IN 1917, BY COUNTIES AND APPARATUS—Continued.

Apparatus and species.	Alcona.		Alpena.		Arenac.		Bay.		Cheboygan.	
Fyke nets:	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*
Carp, Asiatic							8,925	$353		
Catfish and bullheads							1,800	148		
Ciscoes, fresh							6,500	275		
Pike perch (wall-eyed or yellow pike)							12,572	1,431		
Rock bass							400	32		
Suckers					423	$13	54,544	1,514		
Sunfish							200	8		
Whitefish, common							500	80		
Yellow perch					4,800	240	59,571	3,605		
Total					5,223	253	145,012	7,446		
Seines:										
Carp, Asiatic					11,681	482	190,309	7,224		
Catfish and bullheads					700	56	5,438	533		
Pike					100	10	700	60		
Pike perch (wall-eyed or yellow pike)					27,215	2,701	77,777	7,973		
Rock bass							200	8		
Suckers					42,578	1,304	64,187	1,502		
Sunfish							200	8		
Whitefish, common							212	28		
Yellow perch					5,643	373	16,508	1,095		
Total					87,917	4,926	355,531	18,431		
Lines: Trout, lake	350	$42								
Spears:										
Pike perch (wall-eyed or yellow pike)					4,000	560	20,000	2,800		
Yellow perch					500	25	2,000	200		
Total					4,500	585	22,000	3,000		
Grand total	260,118	10,314	282,129	$18,653	552,344	28,190	1,979,486	98,536	598,108	$37,132

Apparatus and species.	Chippewa.		Huron.		Iosco.		Mackinac.		Presque Isle.	
Pound nets and trap nets:	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*
Burbot					824	$24				
Carp, Asiatic			20,700	$828	200	8				
Catfish and bullheads	1,077	$178	4,473	437	300	30				
Ciscoes—										
Fresh			557,028	14,866	488,389	12,777	9,500	$380		
Salted			1,243,019	53,355	125,700	7,542	61,000	2,495		
Muskellunge	100	10								
Pike	6,000	600	284	28	200	16	750	56		
Pike perch (wall-eyed or yellow pike)	19,072	2,779	337,833	46,932	112,242	10,848	2,896	299	500	$50
Rock bass	2,000	100								
Sheepshead or drum			5,300	159						
Sturgeon			930	187	650	160	240	49		
Sturgeon caviar					20	40	20	50		
Suckers—										
Fresh	228,412	13,170	60,411	1,560	39,117	1,695	280,396	13,237	25,877	1,061
Salted							1,000	50		
Sunfish	200	10								
Trout, lake	9,187	919	9,465	701	12,829	1,190	23,929	2,706		
Whitefish—										
Common	1,923	261	94,731	10,184	42,379	4,375	99,942	14,468		
Common caviar			1,075	197						
Menominee					136	6				
Yellow perch	9,371	945	97,354	6,273	5,795	367	49,199	3,869	150	15
Total	277,342	18,972	2,432,603	135,707	828,781	39,078	528,872	37,659	26,527	1,126

YIELD OF THE SHORE FISHERIES OF LAKE HURON IN 1917, BY COUNTIES AND APPARATUS—Continued.

Apparatus and species.	Chippewa.		Huron.		Iosco.		Mackinac.		Presque Isle.	
	Lbs.	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*
Gill nets:										
Burbot							800	$16		
Ciscoes, fresh	47,300	$2,365	27,850	$1,311	4,000	$80	700	34	9,300	$292
Pike perch (wall-eyed or yellow pike)—										
Fresh	10,926	1,501	13,508	1,394	1,789	216	196	40	550	63
Salted									30	3
Suckers	13,300	439	24,900	933	700	14	11,500	545	2,900	100
Trout, lake—										
Fresh	122,480	9,929	33,790	3,379	159,221	15,868	60,604	6,219	3,850	393
Salted	900	90					1,000	150	48	6
Whitefish—										
Common, fresh	15,190	1,622	7,298	904	67,787	7,749	41,353	4,557	3,660	446
Common, salted							2,500	200		
Menominee, fresh	650	52					9,475	513	2,600	220
Menominee, salted							3,800	323		
Yellow perch	15,000	1,280	22,082	1,750			5,984	479	50	4
Total	225,746	17,278	129,428	9,671	233,497	23,927	137,912	13,076	22,988	1,527
Fyke nets:										
Carp, Asiatic			3,500	139						
Catfish and bullheads			1,220	108						
Ciscoes, fresh			500	25						
Pike			135	13						
Pike perch (wall-eyed or yellow pike)			1,584	171						
Sheepshead or drum			50	2						
Suckers			44,685	1,458	300	7				
Yellow perch			44,052	3,636	2,000	160				
Total			95,726	5,552	2,300	167				
Seines:										
Carp, Asiatic			817,701	30,604						
Catfish and bullheads			800	80						
Pike perch (wall-eyed or yellow pike)					1,625	187				
Sheepshead or drum			500	15						
Suckers					2,955	121				
Whitefish, common					3,195	413				
Yellow perch			2,500	250	900	90				
Total			821,501	30,949	8,675	811				
Lines:										
Catfish			8,000	880						
Trout, lake			53,656	5,110	14,500	1,450	3,400	416	1,665	166
Whitefish, common							76	5		
Yellow perch			2,675	200						
Total			64,331	6,190	14,500	1,450	3,476	421	1,665	166
Spears:										
Carp, Asiatic			20,000	1,000						
Pike			2,000	200						
Pike perch (wall-eyed or yellow pike)			21,560	3,375						
Trout, lake			1,250	200						
Yellow perch			7,950	929						
Total			52,760	5,704						
Grand total	503,088	36,250	3,596,349	193,773	1,087,753	65,433	670,260	51,156	51,180	2,819

YIELD OF THE SHORE FISHERIES OF LAKE HURON IN 1917, BY COUNTIES AND APPARATUS—Continued.

Apparatus and species.	St. Clair.		Sanilac.		Tuscola.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Pound nets and trap nets:								
Burbot							1,074	$29
Carp, Asiatic			1,800	$72	6,383	$255	52,731	2,055
Catfish and bullheads			200	16	400	36	13,221	1,284
Ciscoes—								
Fresh	45,914	$1,289	443,257	13,298	24,963	795	2,335,686	62,179
Salted			286,053	12,873			2,098,512	94,860
Muskellunge							145	15
Pike							9,319	882
Pike perch (wall-eyed or yellow pike)	26,320	3,980	19,010	2,594	43,278	3,708	796,757	96,394
Rock bass			50	2			3,383	156
Sheepshead or drum	10,181	382	200	6	300	12	16,881	589
Sturgeon	1,218	287	460	92			4,826	1,048
Sturgeon caviar	122	268	30	67			227	495
Suckers—								
Fresh	6,481	426	4,404	168	15,229	417	1,491,144	64,297
Salted							1,000	50
Sunfish			50	2			950	40
Trout, lake	192	23	3,011	320			72,422	7,385
Whitefish—								
Common	2,107	296	25,369	3,476	273	38	393,938	47,724
Common caviar							1,375	257
Menominee							11,765	300
Yellow perch	731	74	6,051	890	28,936	2,039	630,893	40,370
Total	93,266	7,025	789,945	33,876	119,762	7,300	7,936,249	420,409
Gill nets:								
Bowfin							200	4
Burbot							800	16
Carp, Asiatic							400	16
Catfish and bullheads							150	6
Ciscoes—								
Fresh							108,350	5,101
Salted							2,180	93
Smoked							3,000	120
Pike							100	10
Pike perch (wall-eyed or yellow pike)—								
Fresh							27,481	3,265
Salted							30	3
Suckers							67,363	2,547
Trout, lake—								
Fresh	250	40	19,885	2,100			486,093	46,501
Salted							6,423	694
Whitefish—								
Common, fresh			11,645	2,080			185,105	22 084
Common, salted							3,350	330
Menominee, fresh							24,382	1,463
Menominee, salted							20,017	1,200
Yellow perch			907	82			59,335	4,804
Total	250	40	32,437	4,262			994,759	88,257
Fyke nets:								
Carp, Asiatic					7,050	241	19,475	733
Catfish and bullheads							3,020	256
Ciscoes—								
Fresh							7,000	300
Salted					100	4	100	4
Pike							135	13
Pike perch (wall-eyed or yellow pike)					550	55	14,706	1,657
Rock bass					300	12	700	44
Sheepshead or drum					300	9	350	11
Suckers					4,238	85	104,190	3,077
Sunfish					300	12	500	20
Whitefish, common							500	80
Yellow perch					2,900	272	113,323	7,913
Total					15,738	690	263,999	14,108

YIELD OF THE SHORE FISHERIES OF LAKE HURON IN 1917, BY COUNTIES AND APPARATUS—Continued.

Apparatus and species.	St. Clair.		Sanilac.		Tuscola.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Seines:								
Carp, Asiatic					32,878	$1,357	1,052,695	$39,667
Catfish and bullheads							6,938	669
Pike							800	70
Pike perch (wall-eyed or yellow pike)							106,617	10,861
Rock bass							200	8
Sheepshead or drum							500	15
Suckers							109,720	2,927
Sunfish							200	8
Whitefish, common							3,407	441
Yellow perch							25,551	1,808
Total					32,878	1,357	1,306,502	56,474
Lines:								
Catfish					2,000	200	10,000	1,080
Trout, lake	800	$0.80	19,533	$2,095			93,904	9,359
Whitefish, common							76	5
Yellow perch							2,675	200
Total	800	80	19,533	2,095	2,000	200	106,655	10,644
Spears:								
Carp, Asiatic							20,000	1,000
Pike							2,000	200
Pike perch (wall-eyed or yellow pike)							45,560	6,735
Trout, lake							1,250	200
Yellow perch							10,450	1,154
Total							79,260	9,289
Grand total	94,316	7,145	841,915	40,233	170,378	9,547	10,687,421	599,181

WHOLESALE FISHERY TRADE.

In 1917 there were 23 establishments engaged in the wholesale fishery trade of Lake Huron, employing 147 persons, to whom $95,648 were paid in wages. The value of these establishments with their equipment, etc., was $262,507; and the cash capital utilized amounted to $156,100. Compared with 1903 there was an increase of 7 in the number of establishments, 13 in the number of persons engaged, $57,228 in wages paid, $166,007 in the value of the establishments and their equipment, and $60,600 in cash capital.

The following table shows the extent of the wholesale fishery trade of Lake Huron in 1917:

WHOLESALE FISHERY TRADE OF LAKE HURON IN 1917.

Cities and towns.	State.	Number of firms.	Persons engaged.	Wages paid.	Shore and accessory property.	Cash capital.
Bay City and East Tawas	Michigan	6	57	$44,450	$78,197	$51,500
Alpena	do	4	14	7,300	34,300	37,000
Cheboygan and Rogers	do	3	13	11,280	19,100	25,000
St. Ignace and Detour	do	3	8	4,100	8,800	12,000
Sebewaing, Bayport, Harbor Beach, and Port Huron	do	7	55	28,518	122,110	30,600
Total		23	147	95,648	262,507	156,100

FISHERIES OF LAKE ST. CLAIR AND ST. CLAIR RIVER.

The fisheries of Lake St. Clair and St. Clair River in 1917 gave employment to 64 men. The number of boats in use was 64, valued at $2,540. The apparatus of capture included 6 seines, valued at $1,365, and hand lines to the value of $50; and the shore and accessory property was valued at $12,000. The products of the fisheries amounted to 133,330 pounds, valued at $11,852, of which 85,330 pounds, valued at $4,652, were carp taken with seines and 48,000 pounds, valued at $7,200, pike perch caught with hand lines. Because of legal restrictions, the fisheries of the connecting waters between Lakes Erie and Huron are of much less importance than formerly.

FISHERIES, BY COUNTIES.

The following table shows, by counties, the number of persons employed, investment, and quantity and value of the products of the fisheries in 1917:

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS BY APPARATUS IN THE FISHERIES OF LAKE ST. CLAIR AND ST. CLAIR RIVER IN 1917, BY COUNTIES.

Items.	Macomb.		St. Clair.		Total.	
PERSONS ENGAGED.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
Fishermen	10		54		64	
INVESTMENT.						
Row boats	3	$215	57	$1,425	60	$1,640
Power boats	1	100	3	800	4	900
Seines	1	500	5	865	6	1,365
Hand lines				50		50
Shore and accessory property		2,000		10,000		12,000
Total	5	2,815	65	13,140	70	15,955
PRODUCTS BY APPARATUS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Seines: Carp	50,757	2,436	34,573	2,216	85,330	4,652
Hand lines: Pike perch (wall-eyed or yellow pike)			48,000	7,200	48,000	7,200
Total	50,757	2,436	82,573	9,416	133,330	11,852

FISHERIES OF LAKE ERIE.

In 1917 Lake Erie ranked first among the Great Lakes in the amount of capital invested and quantity and value of the products and second in the number of persons engaged. The fisheries gave employment to 2,770 persons, of which number 1,761 are credited to Ohio, 446 to Pennsylvania, 305 to New York, and 258 to Michigan. Of the total, 565 men were on fishing and transporting vessels, 1,487 in the shore or boat fisheries, and 718 shoresmen in wholesale establishments and other fishery industries on shore.

The amount of capital invested was $4,332,767, which includes 93 fishing vessels of 1,883 net tons, valued at $508,398, with outfits valued at $101,665; 24 transporting vessels, of 304 net tons, valued at $66,100, with outfits valued at $14,655; 1,016 boats, valued at $206,185; fishing apparatus used on vessels and boats to the value of $1,094,713; shore and accessory property valued at $1,884,165; and cash capital utilized in the fishery industries amounting to $456,886. The investment in New York was $655,062; in Pennsylvania, $919,919; in Ohio, $2,462,822; and in Michigan, $294,964. The apparatus used in the fisheries of Lake Erie included 47,578 gill

nets, valued at $329,632; 5,011 pound nets and trap nets, valued at $681,060; 801 fyke nets, valued at $44,403; 285 seines valued at $38,867; and lines to the value of $751.

The products aggregated 38,710,238 pounds, for which the fishermen received $2,327,299. Of this quantity, New York is credited with 2,426,848 pounds, valued at $167,358; Pennsylvania, with 8,151,241 pounds, valued at $508,382; Ohio, with 26,442,993 pounds, valued at $1,570,230; and Michigan, with 1,689,156 pounds, valued at $81,329. Ciscoes are the principal species represented in the fisheries of Lake Erie in both quantity and value, the catch being 17,160,852 pounds, or 44.33 per cent of the total quantity, valued at $1,046,862, or 44.98 per cent of the total value of all products. The pike perch, including sauger, ranked second, the yield being 7,277,701 pounds, valued at $524,439; and carp, third, with a yield of 6,044,792 pounds, valued at $274,139. Other important species include the common whitefish, 1,755,947 pounds, valued at $232,761; sheepshead, 2,855,551 pounds, valued at $69,502; suckers, 1,035,934 pounds, valued at $36,403; and yellow perch, 959,357 pounds, valued at $69,864. The catch of burbot, the use of which for food the Bureau has been encouraging, amounted to 652,870 pounds, valued at $8,027.

In comparison with 1903 there was an increase of 43, or 1.58 per cent, in the number of persons employed; $2,136,370, or 97.27 per cent, in the capital invested in the fisheries; 15,521,682 pounds, or 66.93 per cent, in the quantity, and $1,547,284, or 198.36 per cent, in the value of the products.

FISHERIES, BY STATES AND COUNTIES.

The following tables show, by States and counties, the extent of the fisheries of Lake Erie in 1917:

STATISTICS OF THE FISHERIES OF LAKE ERIE IN 1917, BY STATES AND COUNTIES.

PERSONS ENGAGED.

State and county.	On vessels fishing.	On vessels transporting.	In shore or boat fisheries.	Shoresmen.	Total.
New York:					
Chautauqua	65		61	18	144
Erie	15		37	109	161
Total	80		98	127	305
Pennsylvania: Erie	247	7	47	145	446
Ohio:					
Ashtabula	22		75	30	127
Cuyahoga	63		63	80	206
Erie	77	14	308	133	532
Lake		3	103	33	139
Lorain	21		30	4	55
Lucas	5	13	232	39	289
Ottawa		11	348	42	401
Sandusky			12		12
Total	188	41	1,171	361	1,761
Michigan:					
Monroe			112	10	122
Wayne	2		59	75	[1] 136
Total	2		171	85	258
Grand total	517	48	1,487	718	2,770

[1] Includes persons engaged in the wholesale fish trade of Detroit.

STATISTICS OF THE FISHERIES OF LAKE ERIE IN 1917, BY STATES AND COUNTIES—Continued.

INVESTMENT.

State and county.	Vessels fishing.								Vessels transporting.			
	Steam.				Gasoline.				Steam.			
	Number.	Tonnage.	Value.	Value of outfit.	Number.	Tonnage.	Value.	Value of outfit.	Number.	Tonnage.	Value.	Value of outfit.
New York:												
Chautauqua	9	208	$64,000	$9,680	3	21	$5,300	$900				
Erie	2	28	15,000	550	1	9	2,200	260				
Total	11	236	79,000	10,230	4	30	7,500	1,160				
Pennsylvania: Erie	36	812	238,440	43,684	9	93	18,200	3,276	1	23	$3,000	$250
Ohio:												
Ashtabula	3	65	16,800	3,100	1	8	1,500	350				
Cuyahoga	10	263	71,175	21,900								
Erie	10	250	44,983	11,715	3	31	8,000	1,750	1	43	10,000	3,500
Lorain	3	74	19,000	3,050	1	6	1,000	350	1	17	3,500	150
Lucas					1	10	1,500	1,090				
Ottawa									2	28	8,000	1,300
Total	26	652	151,958	39,765	6	55	12,000	3,540	4	88	21,500	4,950
Michigan: Wayne					1	5	1,300	10				
Grand total	73	1,700	469,398	93,679	20	183	39,000	7,986	5	111	24,500	5,200

State and county.	Vessels transporting—Contd.				Sail and row boats.		Power boats.		Vessel fisheries.	
	Gasoline.								Gill nets.	
	Number.	Tonnage.	Value.	Value of outfit.	Number.	Value.	Number.	Value.	Number.	Value.
New York:										
Chautauqua					3	$75	22	$16,100	6,286	$45,137
Erie					10	285	9	2,575	1,184	8,640
Total					13	360	31	18,675	7,470	53,777
Pennsylvania: Erie					17	765	14	7,200	20,154	141,273
Ohio:										
Ashtabula					29	2,300	23	13,850	2,192	15,320
Cuyahoga					13	210	24	14,300	3,052	18,312
Erie	4	39	$11,500	$2,750	53	1,040	117	42,465	3,974	34,016
Lake	1	31	4,500	300	39	1,250	37	22,950		
Lorain					7	805	4	5,275	766	6,928
Lucas	8	58	15,100	3,880	111	5,890	47	16,025	395	2,900
Ottawa	6	65	10,500	2,525	258	13,225	89	30,635		
Sandusky					6	90				
Total	19	193	41,600	9,455	516	24,810	341	145,500	10,379	77,476
Michigan:										
Monroe					45	1,120	21	5,090		
Wayne					11	315	7	2,350	4	51
Total					56	1,435	28	7,440	4	51
Grand total	19	193	41,600	9,455	602	27,370	414	178,815	38,007	272,577

STATISTICS OF THE FISHERIES OF LAKE ERIE IN 1917, BY STATES AND COUNTIES—Continued.

INVESTMENT—Continued..

State and county.	Apparatus of capture, shore fisheries.									Shore and accessory property.	Cash capital.	Total investment.
	Gill nets.		Pound nets and trap nets.		Fyke nets.		Seines.		Value of lines.			
	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.				
New York:												
Chautauqua..	2,919	$22,376	......	......	......	......	8	$240	$698	$27,691	$23,000	$215,197
Erie..........	403	4,075	30	$2,820	......	......	......	......	......	309,574	93,886	439,865
Total.....	3,322	26,451	30	2,820	......	......	8	240	698	337,265	116,886	655,062
Pennsylvania:												
Erie..........	362	2,214	69	16,930	......	......	......	......	8	366,679	78,000	919,919
Ohio:												
Ashtabula....	420	3,172	457	72,945	......	......	3	65	......	103,022	30,000	262,424
Cuyahoga....	300	2,000	256	32,625	......	......	2	60	......	171,935	22,500	355,017
Erie..........	1,962	10,696	1,557	207,980	97	$3,070	32	6,975	30	286,895	41,000	728,365
Lake..........	20	180	641	86,200	......	......	7	290	......	73,419	25,000	214,089
Lorain.......	222	325	50	11,900	......	......	1	25	15	60,010	2,000	114,333
Lucas.........	......	......	863	127,685	234	20,000	50	3,547	......	155,780	22,000	375,397
Ottawa.......	2,932	11,902	1,002	113,800	192	4,090	117	21,110	......	136,910	52,500	406,497
Sandusky....	25	50	......	......	......	......	7	1,025	......	5,535	......	6,700
Total.....	5,881	28,325	4,826	653,135	523	27,160	219	33,097	45	993,506	195,000	2,462,822
Michigan:												
Monroe.......	5	25	86	8,175	222	16,718	41	3,575	......	23,740	5,000	63,443
Wayne........	1	40	......	......	56	525	17	1,955	......	162,975	62,000	[a] 231,521
Total......	6	65	86	8,175	278	17,243	58	5,530	......	186,715	67,000	294,964
Grand total	9,571	57,055	5,011	681,060	801	44,403	285	38,867	751	1,884,165	456,886	4,332,767

YIELD, BY SPECIES.

State and county.	Bowfin.		Burbot.		Carp, Asiatic.		Catfish and bullheads.		Ciscoes.	
	Lbs.	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*
New York:										
Chatauqua..........	......	......	15,190	$243	27,968	$1,492	695	$81	1,744,054	$115,563
Erie................	......	......	75	2	1,540	78	......	......	299,306	17,522
Total..........	......	......	15,265	245	29,508	1,570	695	81	2,043,360	133,085
Pennsylvania: Erie ..	......	......	148,719	1,541	22,427	718	990	61	7,381,256	447;744
Ohio:										
Ashtabula..........	......	......	69,623	717	7,939	315	2,498	241	630,234	40,406
Cuyahoga...........	......	......	171,929	1,720	19,441	961	5,370	287	3,536,647	209,030
Erie................	3,375	$50	129,037	1,656	965,156	43,821	278,109	14,410	2,806,913	169,092
Lake................	......	......	99,832	1,993	45,851	1,960	11,991	637	62,193	4,048
Lorain..............	......	......	8,635	87	11,289	474	1,025	61	677,616	41,936
Lucas...............	......	......	......	......	907,638	36,345	56,781	3,138	9,467	571
Ottawa..............	1,790	19	9,830	68	2,571,774	127,544	270,748	20,291	12,066	900
Sandusky............	......	......	......	......	60,030	2,700	325	25	......	......
Total..........	5,165	69	488,886	6,241	4,589,118	214,120	626,847	39,090	7,735,136	465,983
Michigan:										
Monroe..............	......	......	......	......	814,666	28,545	......	......	1,100	50
Wayne...............	......	......	......	......	589,073	29,186	......	......	......	......
Total..........	......	......	......	......	1,403,739	57,731	......	......	1,100	50
Grand total.....	5,165	69	652,870	8,027	6,044,792	274,139	628,532	39,232	17,160,852	1,046,862

[a] Includes investment in the wholesale fish trade of Detroit.

STATISTICS OF THE FISHERIES OF LAKE ERIE IN 1917, BY STATES AND COUNTIES—Continued.

YIELD, BY SPECIES—Continued.

State and county.	Gold-eye or moon-eye.		Pike.		Pike perch.				Rock bass.	
					Blue pike.		Wall-eyed or yellow pike.			
	Lbs.	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*
New York:										
Chautauqua					12,489	$1,053	119	$13		
Erie					7,155	616	5,679	706	100	$5
Total					19,644	1,669	5,798	719	100	5
Pennsylvania: Erie			1,238	$148	162,878	13,049	3,214	412		
Ohio:										
Ashtabula					391,146	31,291	12,987	1,298		
Cuyahoga					312,164	14,226	11,773	1,387		
Erie					588,177	30,123	325,037	39,428		
Lake					187,138	14,915	17,932	1,970		
Lorain					54,899	2,882	14,072	1,407		
Lucas	10,335	$104	4,428	402			370,843	48,274		
Ottawa					341,027	27,086	458,880	46,108		
Sandusky							50	5		
Total	10,335	104	4,428	402	1,874,551	120,523	1,211,574	139,877		
Michigan:										
Monroe							66,870	7,755		
Wayne							4,000	400		
Total							70,870	8,155		
Grand total	10,335	104	5,666	550	2,057,073	135,241	1,291,456	149,163	100	5

State and county.	Sauger.		Sheepshead or drum.		Sturgeon.		Sturgeon caviar.		Suckers.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Pounds.*	*Value.*
New York:										
Chautauqua	77,598	$3,879	55	$3	7,563	$1,720	18	$45	28,604	$1,867
Erie					14,576	3,427	1,000	2,000	18,384	721
Total	77,598	3,879	55	3	22,139	5,147	1,018	2,045	46,988	2,588
Pennsylvania: Erie	33,993	2,245	10,863	309	2,730	348			28,626	824
Ohio:										
Ashtabula	41,656	2,406	18,795	826	34	6			23,991	724
Cuyahoga	102,410	4,162	84,954	1,720	128	13			32,092	1,247
Erie	2,344,241	154,930	1,520,818	40,544	1,623	196			376,827	12,697
Lake	116,415	7,431	68,851	1,799	33	8			32,538	1,038
Lorain	20,362	1,368	33,383	674	500	85			5,865	120
Lucas	198,450	11,937	309,716	6,193	330	69			166,403	4,992
Ottawa	994,047	51,677	804,116	17,314	427	105			219,602	8,510
Sandusky			4,000	120						
Total	3,817,581	233,911	2,844,633	69,190	3,075	482			857,318	29,328
Michigan:										
Monroe					440	87			87,502	3,298
Wayne									15,500	365
Total					440	87			103,002	3,663
Grand total	3,929,172	240,035	2,855,551	69,502	28,384	6,064	1,018	2,045	1,035,934	36,403

STATISTICS OF THE FISHERIES OF LAKE ERIE IN 1917, BY STATES AND COUNTIES—Continued.

YIELD, BY SPECIES—Continued.

State and county.	Trout, lake.		White bass.		Whitefish, common.		Yellow perch.		Total.	
	Lbs.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Lbs.*	*Value.*	*Pounds.*	*Value.*
New York:										
Chautauqua	734	$91	30	$2	139,225	$13,964	13,486	$1,108	2,067,828	$141,124
Erie	807	65			3,843	546	6,555	546	359,020	26,234
Total	1,541	156	30	2	143,068	14,510	20,041	1,654	2,426,848	167,358
Pennsylvania: Erie	120	13	1,323	118	300,293	37,015	52,571	3,837	8,151,241	508,382
Ohio:										
Ashtabula			7,354	586	95,295	14,128	46,903	3,610	1,348,455	96,554
Cuyahoga			13,307	577	98,046	13,655	33,701	2,072	4,421,962	251,057
Erie	261	32	89,272	6,010	240,253	30,876	349,911	23,002	10,019,010	566,867
Lake			2,040	144	61,795	9,257	27,981	2,238	734,590	47,438
Lorain			5,625	340	38,276	4,311	20,840	1,315	892,387	55,060
Lucas			101,470	6,088	316,137	44,262	141,950	11,375	2,593,948	173,750
Ottawa			65,591	3,340	435,509	61,046	182,729	12,639	6,368,136	376,647
Sandusky			100	7					64,505	2,857
Total	261	32	284,759	17,092	1,285,311	177,535	804,015	56,251	26,442,993	1,570,230
Michigan:										
Monroe					27,275	3,701	79,363	7,680	1,077,216	51,116
Wayne							3,367	262	611,940	30,213
Total					27,275	3,701	82,730	7,942	1,689,156	81,329
Grand total	1,922	201	286,112	17,212	1,755,947	232,761	959,357	69,684	38,710,238	2,327,299

FISHERIES, BY APPARATUS.

The catch of the vessel fisheries amounted to 17,151,247 pounds, valued at $1,057,079, and of the shore or boat fisheries to 21,558,991 pounds, valued at $1,270,220. The catch of the vessel fisheries was all taken with gill nets, the principal species being ciscoes to the amount of 15,497,879 pounds, valued at $949,894; pike perch and sauger, 710,951 pounds, valued at $43,508; common whitefish, 388,614 pounds, valued at $45,914; burbot, 288,142 pounds, valued at $2,881; and yellow perch, 174,837 pounds, valued at $11,883.

The catch with the principal forms of apparatus used in the shore or boat fisheries was as follows: Pound nets and trap nets, 13,319,548 pounds, consisting principally of sauger, pike perch, sheepshead or drum, whitefish, ciscoes, and yellow perch, valued at $840,640; seines, 5,505,997 pounds, mainly carp, valued at $251,409; gill nets, 1,853,294 pounds, mainly ciscoes, valued at $123,293; fyke nets, 857,176 pounds, consisting principally of carp, pike perch, sheepshead, suckers, sauger, and yellow perch, valued at $51,971; and set lines, 20,976 pounds, consisting principally of catfish, bullheads, and sturgeon, valued at $2,807.

The following tables give the products of the vessel and shore fisheries of Lake Erie, by States and counties, in 1917:

YIELD OF GILL-NET VESSEL FISHERIES OF LAKE ERIE IN 1917, BY STATES, COUNTIES, AND SPECIES.

Species.	New York.						Pennsylvania.	
	Chautauqua.		Erie.		Total.		Erie.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Burbot	12,542	$126	75	$2	12,617	$128	136,162	$1,384
Carp, Asiatic	348	14			348	14	20,127	611
Ciscoes	1,341,656	90,643	182,476	11,043	1,524,132	101,686	6,965,349	425,556
Pike							60	7
Pike perch:								
Blue pike	4,152	333	1,945	161	6,097	494	134,776	10,777
Wall-eyed or yellow pike	119	13			119	13	381	45
Sauger	77,598	3,879			77,598	3,879	27,993	1,945
Sheepshead or drum	55	3			55	3	88	2
Suckers	3,351	143			3,351	143	7,041	127
Trout, lake	451	38	807	65	1,258	103	102	11
White bass	30	2			30	2		
Whitefish, common	102,278	9,987	3,633	524	105,911	10,511	217,046	25,978
Yellow perch	5,191	419	2,690	199	7,881	618	35,502	2,488
Total	1,547,771	105,600	191,626	11,994	1,739,397	117,594	7,544,627	468,931

Species.	Ohio.							
	Ashtabula.		Cuyahoga.		Erie.		Lorain.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Burbot	266	$5	94,129	$940	44,868	$423	100	$1
Carp, Asiatic	45	2			27	1	600	24
Catfish and bullheads					23	3		
Ciscoes	518,419	34,358	3,449,050	203,576	2,393,014	144,528	639,363	39,675
Pike perch:								
Blue pike	19,444	1,556	239,671	10,026	21,634	1,765	12,981	1,034
Wall-eyed or yellow pike	50	4			1,444	134	40	5
Sauger	8,383	451			140,496	9,987	16,030	1,088
Sheepshead or drum	770	39			2,796	62	100	3
Suckers	1,391	43	23,864	949	25,554	710	500	8
Trout, lake					261	32		
White bass					10	1	100	5
Whitefish, common	50,712	7,607	13,451	1,614	225	26	65	8
Yellow perch	5,875	443	14,000	840	72,558	4,682	16,575	997
Total	605,385	44,508	3,834,165	217,945	2,702,910	162,354	686,454	42,848

Species.	Ohio—Continued.				Michigan.		Grand total.	
	Lucas.		Total.		Wayne.			
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Burbot			139,363	$1,369			288,142	$2,881
Carp, Asiatic			672	27			21,147	652
Catfish and bullheads	252	$21	275	24			275	24
Ciscoes	8,522	515	7,008,398	422,652			15,497,879	949,894
Pike	376	38	376	38			436	45
Pike perch:								
Blue pike			293,730	14,381			434,603	25,652
Wall-eyed or yellow pike	338	45	1,872	188	500	$50	2,872	296
Sauger	2,976	210	167,885	11,736			273,476	17,560
Sheepshead or drum	1,575	32	5,241	136			5,384	141
Suckers	120	3	51,429	1,713			61,821	1,983
Trout, lake			261	32			1,621	146
White bass			110	6			140	8
Whitefish, common	1,204	170	65,657	9,425			388,614	45,914
Yellow perch	21,946	1,775	130,954	8,737	500	40	174,837	11,883
Total	37,309	2,809	7,866,223	470,464	1,000	90	17,151,247	1,057,079

YIELD OF SHORE FISHERIES OF LAKE ERIE IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES.

Apparatus and species.	New York.						Pennsylvania.	
	Chatauqua.		Erie.		Total.		Erie.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Pound nets and trap nets:								
Burbot							7,496	$106
Carp, Asiatic			1,140	$58	1,140	$58	2,300	107
Catfish and bullheads							990	61
Ciscoes			50	3	50	3	301,874	15,722
Pike							1,178	141
Pike perch—								
Blue pike			2,060	173	2,060	173	23,594	1,886
Wall-eyed or yellow pike			5,679	706	5,679	706	2,833	367
Rock bass			100	5	100	5		
Sauger							6,000	300
Sheepshead or drum							10,775	307
Sturgeon			1,876	513	1,876	513	2,175	298
Suckers			13,784	502	13,784	502	21,385	695
Trout, lake							18	2
White bass							1,323	118
Whitefish, common							79,350	10,396
Yellow perch			1,865	147	1,865	147	16,799	1,327
Total			26,554	2,107	26,554	2,107	478,090	31,833
Gill nets:								
Burbot	2,648	$117			2,648	117	5,061	51
Carp, Asiatic			400	20	400	20		
Ciscoes	402,398	24,920	116,780	6,476	519,178	31,396	114,033	6,466
Pike perch—Blue pike	8,337	720	3,150	282	11,487	1,002	4,508	386
Sturgeon			12,700	2,914	12,700	2,914		
Sturgeon caviar			1,000	2,000	1,000	2,000		
Suckers	3,853	208	4,600	219	8,453	427	200	2
Trout, lake	283	53			283	53		
Whitefish, common	36,947	3,977	210	22	37,157	3,999	3,897	641
Yellow perch	8,295	689	2,000	200	10,295	889	270	22
Total	462,761	30,684	140,840	12,133	603,601	42,817	127,969	7,568
Seines:								
Carp, Asiatic	27,620	1,478			27,620	1,478		
Catfish and bullheads	695	81			695	81		
Suckers	21,400	1,516			21,400	1,516		
Total	49,715	3,075			49,715	3,075		
Set lines:								
Sturgeon	7,563	1,720			7,563	1,720	555	50
Sturgeon caviar	18	45			18	45		
Total	7,581	1,765			7,581	1,765	555	50
Grand total	520,057	35,524	167,394	14,240	687,451	49,764	606,614	39,451

YIELD OF SHORE FISHERIES OF LAKE ERIE IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Ohio.									
	Ashtabula.		Cuyahoga.		Erie.		Lake.		Lorain.	
	Lbs.	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*
Pound nets and trap nets:										
Bowfin					3,375	$50				
Burbot	68,777	$702	77,800	$780	83,564	1,225	99,832	$1,993	8,535	$86
Carp, Asiatic	2,329	94	16,841	811	143,971	6,315	7,863	315	8,092	325
Catfish and bullheads	1,377	129	5,370	287	175,744	9,252	11,637	609	825	49
Ciscoes	91,130	4,705	47,397	3,042	105,786	6,187	62,193	4,048	37,600	2,211
Pike perch—										
Blue pike	371,002	29,679	71,128	4,090	564,723	28,256	186,705	14,880	41,818	1,840
Wall-eyed or yellow pike	12,868	1,287	11,773	1,387	310,654	37,820	17,932	1,970	14,032	1,402
Sauger	33,133	1,947	102,410	4,162	2,017,175	132,465	116,415	7,431		
Sheepshead or drum	17,315	751	84,954	1,720	1,313,371	35,443	65,851	1,734	32,901	662
Sturgeon	34	6	128	13	1,623	196	33	8	500	85
Suckers	22,190	666	7,928	289	313,521	10,808	30,110	962	5,215	107
White bass	7,204	574	13,307	577	81,739	5,438	1,857	129	5,425	325
Whitefish, common	36,243	5,270	84,420	12,016	223,470	28,785	60,195	9,017	38,211	4,303
Yellow perch	40,978	3,163	19,651	1,229	236,980	15,660	27,981	2,238	3,587	266
Total	704,580	48,973	543,107	30,403	5,575,696	317,900	688,604	45,334	196,741	11,661
Fyke nets:										
Carp, Asiatic					85,955	6,017				
Catfish and bullheads					34,387	1,585				
Pike perch—Wall-eyed or yellow pike					9,368	1,070				
Sauger					68,772	4,350				
Sheepshead or drum					42,914	1,065				
Suckers					22,435	695				
White bass					5,958	468				
Yellow perch					4,090	260				
Total					273,879	15,510				
Gillnets:										
Burbot	580	10			105	2				
Carp, Asiatic	855	34			255,863	10,885			97	5
Catfish and bullheads	1,025	102			3,375	162				
Ciscoes	20,510	1,333	40,200	2,412	308,113	18,377			653	50
Pike perch—										
Blue pike	600	48	1,365	110	1,563	85	200	16		
Wall-eyed or yellow pike					2,459	287				
Sauger	115	7			116,223	8,027			4,182	268
Sheepshead or drum	360	18			46,248	1,040			232	5
Suckers	275	8	300	9	14,973	473				
White bass					45	3				
Whitefish, common	6,660	999	175	25	16,558	2,065	1,600	240		
Yellow perch	50	4	50	3	35,548	2,347			653	50
Total	31,030	2,563	42,090	2,559	801,073	43,753	1,800	256	5,817	378
Seines:										
Carp, Asiatic	4,710	185	2,600	150	479,240	20,598	37,988	1,645	500	20
Catfish and bullheads	96	10			55,055	2,640	354	28		
Ciscoes	145	10								
Pike perch—										
Blue pike	100	8			157	9	233	19		
Wall-eyed or yellow pike	69	7			312	32				
Sauger	25	1			1,375	86				
Sheepshead or drum	350	18			115,429	2,932	3,000	65		
Suckers	135	7			344	11	2,428	76		
White bass	150	12			1,440	95	183	15		
White fish, common	1,680	252								
Yellow perch					135	8				
Total	7,460	510	2,600	150	653,487	26,411	44,186	1,848	500	20
Set lines:										
Burbot					500	6				
Carp					100	5				
Catfish and bullheads					9,525	768			200	12
Pike perch—										
Blue pike					100	8			100	8
Wall-eyed or yellow pike					800	85				
Sauger					200	15			150	12
Sheepshead or drum					60	2			150	4
Suckers									150	5
White bass					80	5			100	10
Yellow perch					600	45			25	2
Total					11,965	939			875	53
Minor apparatus: Carp, Asiatic									2,000	100
Grand total	743,070	52,046	587,797	33,112	7,316,100	404,513	734,590	47,438	205,933	12,212

YIELD OF SHORE FISHERIES OF LAKE ERIE IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Ohio—Continued.							
	Lucas.		Ottawa.		Sandusky.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Pound nets and trap nets:								
Bowfin			410	$5			3,785	$55
Burbot			9,645	64			348,153	4,850
Carp, Asiatic	142,856	$5,715	114,693	5,370			436,645	18,945
Catfish and bullheads	41,111	2,272	123,268	9,332			359,332	21,930
Ciscoes	945	56	10,164	782			355,215	21,031
Gold-eye or moon-eye	875	9					875	9
Pike	4,052	364					4,052	364
Pike perch—								
Blue pike			335,689	26,627			1,571,065	105,372
Wall-eyed or yellow pike	311,345	40,538	438,557	44,068			1,117,161	128,472
Sauger	191,111	11,466	924,319	47,714			3,384,563	205,185
Sheepshead or drum	280,196	5,603	689,501	14,999			2,484,089	60,912
Sturgeon	330	69	427	105			3,075	482
Suckers	146,631	4,400	206,805	8,016			732,400	25,248
White bass	63,935	3,836	46,657	2,392			220,124	13,271
Whitefish, common	314,921	44,088	311,968	44,196			1,069,428	147,675
Yellow perch	118,493	9,479	173,776	12,030			621,446	44,065
Total	1,616,801	127,895	3,385,879	215,700			12,711,408	797,866
Fyke nets:								
Bowfin			1,380	14			1,380	14
Burbot			40	1			40	1
Carp, Asiatic	35,245	1,409	64,598	2,583			185,798	10,009
Catfish and bullheads	11,983	670	14,124	1,052			60,494	3,307
Gold-eye or moon-eye	9,460	95					9,460	95
Pike perch—								
Blue pike			3,693	295			3,693	295
Wall-eyed or yellow pike	59,085	7,681	1,094	110			69,547	8,861
Sauger	4,316	258	3,635	182			76,723	4,790
Sheepshead or drum	24,175	483	32,305	646			99,394	2,194
Suckers	10,405	312	4,755	190			37,595	1,197
White bass	37,500	2,250	14,985	750			58,443	3,468
Whitefish, common	12	4					12	4
Yellow perch	1,459	117	720	55			6,269	432
Total	193,640	13,279	141,329	5,878			608,848	34,667
Gill nets:								
Burbot			25	1			710	13
Carp, Asiatic			18,405	910	4,600	$200	279,820	12,034
Catfish and bullheads			400	34			4,800	298
Ciscoes			1,902	118			371,378	22,290
Pike perch—								
Blue pike			1,645	164			5,373	423
Wall-eyed or yellow pike			12,971	1,305			15,430	1,592
Sauger			65,243	3,738			185,763	12,040
Sheepshead or drum			2,445	62			49,285	1,125
Suckers			3,281	113			18,829	603
White bass			244	13			289	16
Whitefish, common			118,652	16,117			143,645	19,446
Yellow perch			5,958	383			42,259	2,787
Total			231,171	22,958	4,600	200	1,117,581	72,667
Seines:								
Burbot			120	2			120	2
Carp, Asiatic	729,537	29,221	2,374,078	118,681	55,430	2,500	3,684,083	173,000
Catfish and bullheads	3,435	175	132,956	9,873	325	25	192,221	12,751
Ciscoes							145	10
Pike perch—								
Blue pike							490	36
Wall-eyed or yellow pike	75	10	6,258	625	50	5	6,764	679
Sauger	47	3	850	43			2,297	133
Sheepshead or drum	3,770	75	79,865	1,607	4,000	120	206,414	4,817
Suckers	9,247	277	4,761	191			16,915	562
White bass	35	2	3,705	185	100	7	5,613	316
White fish, common			4,889	733			6,569	985
Yellow perch	52	4	2,275	171			2,462	183
Total	746,198	29,767	2,609,757	132,111	59,905	2,657	4,124,093	193,474

YIELD OF SHORE FISHERIES OF LAKE ERIE IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Ohio—Continued.							
	Lucas.		Ottawa.		Sandusky.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Set lines:								
Burbot							500	$6
Carp							100	5
Catfish and bullheads							9,725	780
Pike perch—								
Blue pike							200	16
Wall-eyed or yellow pike							800	85
Sauger							350	27
Sheepshead or drum							210	6
Suckers							150	5
White bass							180	15
Yellow perch							625	47
Total							12,840	992
Minor apparatus:								
Carp, Asiatic							2,000	100
Grand total	2,556,639	$170,941	6,358,136	$376,647	64,505	$2,857	18,576,770	1,099,766

Apparatus and species.	Michigan.						Grand total.	
	Monroe.		Wayne.		Total.			
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Pound nets and trap nets:								
Bowfin							3,785	$55
Burbot							355,649	4,956
Carp, Asiatic	10,000	$300			10,000	$300	450,085	19,410
Catfish and bullheads							360,322	21,991
Ciscoes	1,100	50			1,100	50	658,239	36,806
Gold-eye or moon-eye							875	9
Pike							5,230	505
Pike perch—								
Blue pike							1,596,719	107,431
Wall-eyed or yellow pike	27,432	3,226			27,432	3,226	1,153,105	132,771
Rock bass							100	5
Sauger							3,390,563	205,485
Sheepshead or drum							2,494,864	61,219
Sturgeon	400	80			400	80	7,526	1,373
Suckers	25,143	545			25,143	545	792,712	26,990
Trout, lake							18	2
White bass							221,447	13,389
Whitefish, common	27,275	3,701			27,275	3,701	1,176,053	161,772
Yellow perch	12,146	932			12,146	932	652,256	46,471
Total	103,496	8,834			103,496	8,834	13,319,548	840,640
Fyke nets:								
Bowfin							1,380	14
Burbot							40	1
Carp, Asiatic	46,815	1,821	39,500	$1,533	86,315	3,354	272,113	$13,363
Catfish and bullheads							60,494	3,307
Gold-eye or moon-eye							9,460	95
Pike perch—								
Blue pike							3,693	295
Wall-eyed or yellow pike	36,558	4,241	2,800	280	39,358	4,521	108,905	13,382
Sauger							76,723	4,790
Sheepshead or drum							99,394	2,194
Sturgeon	15	2			15	2	15	2
Suckers	45,569	2,434	10,000	245	55,569	2,679	93,164	3,876
White bass							58,443	3,468
Whitefish, common							12	4
Yellow perch	65,147	6,602	1,924	146	67,071	6,748	73,340	7,180
Total	194,104	15,100	54,224	2,204	248,328	17,304	857,176	51,971

YIELD OF SHORE FISHERIES OF LAKE ERIE IN 1917, BY STATES, COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Michigan.						Grand total.	
	Monroe.		Wayne.		Total.			
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Gill nets:								
Burbot							8,419	$181
Carp, Asiatic	850	$38			850	$38	281,070	12,092
Catfish and bullheads							4,800	298
Ciscoes							1,004,589	60,152
Pike perch—								
Blue pike							21,368	1,811
Wall-eyed or yellow pike	150	15	700	$70	850	85	16,280	1,677
Sauger							185,763	12,040
Sheepshead or drum							49,285	1,125
Sturgeon							12,700	2,914
Sturgeon caviar							1,000	2,000
Suckers	800	16	500	10	1,300	26	28,782	1,058
Trout, lake							283	53
White bass							289	16
Whitefish, common							184,699	24,086
Yellow perch	200	16	943	76	1,143	92	53,967	3,790
Total	2,000	85	2,143	156	4,143	241	1,853,294	123,293
Seines:								
Burbot							120	2
Carp, Asiatic	757,001	26,386	549,573	27,653	1,306,574	54,039	5,018,277	228,517
Catfish and bullheads							192,916	12,832
Ciscoes							145	10
Pike perch—								
Blue pike							490	36
Wall-eyed or yellow pike	2,730	273			2,730	273	9,494	952
Sauger							2,297	133
Sheepshead or drum							206,414	4,817
Sturgeon	25	5			25	5	25	5
Suckers	15,990	303	5,000	110	20,990	413	59,305	2,491
White bass							5,613	316
White fish, common							6,569	985
Yellow perch	1,870	130			1,870	130	4,332	313
Total	777,616	27,097	554,573	27,763	1,332,189	54,860	5,505,997	251,409
Set lines:								
Burbot							500	6
Carp							100	5
Catfish and bullheads							9,725	780
Pike perch—								
Blue pike							200	16
Wall-eyed or yellow pike							800	85
Sauger							350	27
Sheepshead or drum							210	6
Sturgeon							8,118	1,770
Sturgeon caviar							18	45
Suckers							150	5
White bass							180	15
Yellow perch							625	47
Total							20,976	2,807
Minor apparatus:								
Carp, Asiatic							2,000	100
Grand total	1,077,216	51,116	610,940	30,123	1,688,156	83,239	21,558,991	1,270,220

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WHOLESALE FISHERY TRADE.

There were 70 establishments engaged in the wholesale fishery trade of Lake Erie in 1917, employing 728 persons, to whom $565,053 were paid in wages, representing a total investment of $1,559,788 and utilizing cash capital to the amount of $456,886. Compared with 1903, there was an increase of 38 in the number of establishments, 230 in the number of persons employed, $296,515 in wages paid, and $746,804 in the investment, including cash or working capital.

The following table shows the extent of the wholesale fishery trade of Lake Erie in 1917:

WHOLESALE FISHERY TRADE OF LAKE ERIE IN 1917.

Cities.	State.	Number of firms.	Persons engaged.	Wages paid.	Shore and accessory property.	Cash capital.
Buffalo	New York	9	109	$78,913	$308,724	$93,886
Dunkirk and Westfield	do	3	28	16,472	24,641	23,000
Erie	Pennsylvania	7	145	90,086	324,529	78,000
Cleveland	Ohio	7	80	69,839	151,610	22,500
Toledo	do	4	39	31,842	126,970	22,000
Port Clinton	do	5	42	29,719	84,138	52,500
Sandusky	do	5	82	104,151	156,500	23,000
Grand River	do	4	33	19,251	12,019	25,000
Huron, Vermilion, and Lorain	do	7	55	32,360	108,200	20,000
Ashtabula	do	3	30	35,798	94,357	30,000
Detroit and Monroe	Michigan	16	85	56,622	168,100	67,000
Total		70	728	565,053	1,559,788	456,886

FISHERIES OF LAKE ONTARIO AND CERTAIN TRIBUTARIES.

FISHERIES OF LAKE ONTARIO.

In 1917 the fishing industry of Lake Ontario gave employment to 289 persons, 4 of whom were on fishing and transporting vessels, 274 in the shore or boat fisheries, and the remainder employed as shoresmen.

The investment amounted to $132,653, which included 2 vessels of 18 net tons, valued at $2,585, including outfits; 196 boats, valued at $18,900; fishery apparatus used on vessels and boats, valued at $41,243; shore and accessory property to the value of $49,925; and cash capital amounting to $20,000. The apparatus included 165 gill nets, valued at $15,175; 353 trap nets, valued at $21,460; 334 fyke nets, valued at $4,374; and seines, set lines, etc., to the value of $234.

The products of the fisheries amounted to 915,616 pounds, valued at $84,113. The catch of the more important species was made up of 424,744 pounds of ciscoes, value $38,115; common whitefish, 88,347 pounds, value $11,720; suckers, 71,826 pounds, value $5,350; burbot, 61,760 pounds, value $2,388; catfish and bullheads, 45,124 pounds, value $5,719; eels, 41,424 pounds, value $3,249; and pike perch, 35,688 pounds, value $4,083.

Compared with 1903 there was a decrease of 16, or 5.25 per cent, in the number of persons employed and of 159,832 pounds, or 14.86 per cent, in the quantity of the products, and an increase of $36,374, or 76.19 per cent, in the value of the products and of $38,274, or 40.55 per cent, in the investment.

FISHERIES, BY COUNTIES.—The following table shows, by counties, the extent of the fisheries of Lake Ontario in 1917:

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS, BY SPECIES, IN THE FISHERIES OF LAKE ONTARIO IN 1917, BY COUNTIES.

Items.	Cayuga.		Jefferson.		Monroe.		Niagara.	
PERSONS ENGAGED.	*Number*	*Value.*	*Number*	*Value.*	*Number*	*Value.*	*Number*	*Value.*
In shore or boat fisheries	29		89		23		31	
Shoresmen			11					
Total	29		100		23		31	
INVESTMENT.								
Rowboats	24	$480	30	$660	7	$195	7	$170
Power boats	1	1,500	27	5,890	5	625	13	2,175
Apparatus, shore fisheries:								
Trap nets	46	3,800	244	15,390				
Gill nets	4	270	40	5,645	16	915	30	1,680
Fyke nets			240	3,459				
Seines							1	50
Set lines				18		9		41
Scap nets			2	6				
Shore and accessory property		650		41,215		425		2,000
Cash capital				20,000				
Total		6,700		92,283		2,169		6,119
PRODUCTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Burbot			2,163	44	6,185	421		
Carp, Asiatic	244	19	9,043	483			6,120	325
Catfish and bullheads	1,300	224	32,514	4,135	377	34	153	19
Ciscoes:								
Fresh	96,680	7,321	59,271	4,066	5,622	477	30,222	1,755
Salted			6,909	801				
Eels	134	9	40,393	3,153				
Pike			15,330	2,029	93	12	20	3
Pike perch:								
Blue pike			12,798	1,650	2,254	207	14,177	1,293
Wall-eyed or yellow perch			1,674	322	546	66	60	12
Rock bass			7,291	443	162	13		
Sheepshead or drum			300	23				
Suckers			59,261	4,516	2,985	161	381	11
Sunfish	2,701	123	12,972	713				
Sturgeon			3,872	888	370	60	2,906	669
Sturgeon caviar							6	18
Trout, lake			10,600	1,287	366	65	222	34
Whitefish, common			17,117	2,011	7,522	1,082	31,733	3,771
Yellow perch	500	50	27,037	1,434	615	68	160	14
Total	101,559	7,746	318,545	27,998	27,097	2,666	86,160	7,924

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS, BY SPECIES, IN THE FISHERIES OF LAKE ONTARIO IN 1917, BY COUNTIES—Continued.

Items.	Orleans.		Oswego.		Wayne.		Total.	
PERSONS ENGAGED.	*Number*	*Value.*	*Number*	*Value.*	*Number*	*Value.*	*Number*	*Value.*
On vessels, fishing					2		2	
On vessels, transporting					2		2	
In shore or boat fisheries	8		46		48		274	
Shoresmen							11	
Total	8		46		52		289	
INVESTMENT.								
Vessles fishing, gasoline					1	$1,200	1	$1,200
Tonnage					8		8	
Outfit						20		20
Vessels transporting, gasoline					1	1,300	1	1,300
Tonnage					10		10	
Outfit						65		65
Rowboats	3	$150	24	$900	30	465	125	3,020
Power boats	1	300	13	2,390	11	3,000	71	15,880
Apparatus, vessel fisheries: Gill nets					3	40	3	40
Apparatus, shore fisheries:								
Trap nets					63	2,270	353	21,460
Gill nets	7	450	37	3,045	28	3,130	162	15,135
Fyke nets			70	675	24	240	334	4,374
Seines					2	65	3	115
Set lines		22		10		10		113
Scap nets							2	6
Shore and accessory property		300		3,635		1,700		49,925
Cash capital								20,000
Total		1,222		10,655		13,505		132,653
PRODUCTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Bowfin			2,341	$105	4,705	$245	7,046	$350
Burbot			4,247	297	49,165	1,626	61,760	2,388
Carp, Asiatic			87	5	10,088	519	25,582	1,351
Catfish and bullheads			2,131	320	8,649	987	45,124	5,719
Ciscoes:								
Fresh	2,390	$490	70,229	10,269	151,421	12,686	415,835	37,064
Salted			2,000	250			8,909	1,051
Eels	227	25	527	47	143	15	41,424	3,249
Pike	50	8	257	40	71	1	15,821	2,093
Pike perch:								
Blue pike	425	78	1,551	203	1,933	202	33,138	3,633
Wall-eyed or yellow perch	100	20	100	16	70	14	2,550	450
Rock bass					22	2	7,475	458
Sheepshead or drum							300	23
Suckers	1,350	150	5,921	367	1,928	145	71,826	5,350
Sunfish			2,690	181	5,522	310	23,885	1,327
Sturgeon	140	43	2,540	670	1,020	375	10,848	2,705
Sturgeon caviar			125	400			131	418
Trout, lake	300	42	12,146	1,388	60	2	23,694	2,818
Whitefish, common	3,500	700	20,154	2,885	8,321	1,271	88,347	11,720
Yellow perch	48	8	246	36	3,315	336	31,921	1,946
Total	8,530	1,564	127,292	17,479	246,433	18,736	915,616	84,113

FISHERIES, BY APPARATUS.—The catch of the vessel fisheries amounted to 4,930 pounds, valued at $413, consisting of 4,500 pounds of ciscoes, value $360; 200 pounds of whitefish, value $30; and 230 pounds of yellow perch, value $23, all of which was taken with gill nets by a vessel in Wayne County.

The catch taken by boats amounted to 910,686 pounds, valued at $83,700, of which gill nets took 402,170 pounds, value $43,112; trap nets, 359,298 pounds, value $28,826; fyke nets, 89,312 pounds, value $8,823; seines, 54,386 pounds, value $1,704; lines, 4,688 pounds, value $1,159; and scap or dip nets, 832 pounds, value $76. The principal species taken with trap nets were catfish and bullheads, ciscoes, eels, suckers, sunfish, and yellow perch; with gill nets, burbot, ciscoes, pike perch, suckers, lake trout, and whitefish; with fyke nets, catfish and bullheads, eels, pike, suckers, sunfish, and yellow perch; and with

lines, sturgeon and eels. The catch of the seines consisted of burbot carp, catfish, and bullheads; and of scap or dip nets, suckers.

The following table gives the products of the shore fisheries, by counties, in 1917:

YIELD OF SHORE FISHERIES OF LAKE ONTARIO IN 1917, BY COUNTIES, APPARATUS, AND SPECIES.

Apparatus and species.	Cayuga.		Jefferson.		Monroe.		Niagara.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Trap nets:								
Burbot			1,663	$34				
Carp, Asiatic	244	$19	8,167	423				
Catfish and bullheads	1,300	224	19,252	2,274				
Ciscoes—								
Fresh	94,360	7,189	15,858	1,133				
Salted			150	18				
Eels	134	9	29,823	2,165				
Pike			9,929	1,289				
Pike perch—								
Blue pike			10,585	1,463				
Wall-eyed or yellow pike			1,611	313				
Rock bass			7,031	384				
Sheepshead or drum			300	23				
Suckers			26,633	1,757				
Sunfish	2,701	123	9,741	467				
Sturgeon			177	31				
Trout, lake			1,006	129				
Whitefish, common			2,757	287				
Yellow perch			16,760	913				
Total	98,739	7,564	161,443	13,103				
Gill nets:								
Burbot			500	10	6,185	$421		
Carp, Asiatic							100	$8
Catfish and bullheads					377	34		
Ciscoes—								
Fresh	2,320	132	43,413	2,933	5,622	477	30,217	1,754
Salted			6,759	783				
Pike			37	7	93	12	20	3
Pike perch—								
Blue pike			2,213	187	2,254	207	14,177	1,293
Wall-eyed or yellow pike			63	9	516	66	60	12
Rock bass					162	13		
Sturgeon			3,377	758	145	20	315	60
Suckers			379	22	2,985	161	381	11
Trout, lake			9,594	1,158	366	65	222	34
Whitefish, common			14,360	1,724	7,522	1,082	31,733	3,771
Yellow perch	500	50	1,476	74	615	68	160	14
Total	2,820	182	82,171	7,665	26,872	2,626	77,385	6,960
Fyke nets:								
Carp, Asiatic			876	60				
Catfish and bullheads			13,262	1,861				
Eels			10,337	972				
Pike			5,364	733				
Rock bass			260	59				
Suckers			31,417	2,661				
Sunfish			3,231	246				
Yellow perch			8,801	447				
Total			73,548	7,039				
Seines:								
Carp, Asiatic							6,020	317
Catfish and bullheads							130	16
Total							6,150	333
Lines:								
Catfish and bullheads							23	3
Ciscoes							5	1
Eels			233	16				
Sturgeon			318	99	225	40	2,591	609
Sturgeon caviar							6	18
Total			551	115	225	40	2,625	631
Scap nets: Suckers			832	76				
Grand total	101,559	7,746	318,545	27,998	27,097	2,666	86,160	7,924

YIELD OF SHORE FISHERIES OF LAKE ONTARIO IN 1917, BY COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Orleans.		Oswego.		Wayne.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Trap nets:								
Bowfin					3,705	$197	3,705	$197
Burbot							1,663	34
Carp, Asiatic					2,039	159	10,450	601
Catfish and bullheads					6,513	707	27,065	3,205
Ciscoes—								
Fresh					74,944	5,858	185,162	14,180
Salted							150	18
Eels					143	15	30,100	2,189
Pike							9,929	1,289
Pike perch—								
Blue pike							10,585	1,463
Wall-eyed or yellow pike							1,611	313
Rock bass					22	2	7,053	386
Sheepshead or drum							300	23
Suckers					540	39	27,173	1,796
Sunfish					4,749	265	17,191	855
Sturgeon					400	120	577	151
Trout, lake					60	2	1,066	131
Whitefish, common					3,926	589	6,683	876
Yellow perch					2,075	206	18,835	1,119
Total					99,116	8,159	359,298	28,826
Gill nets:								
Burbot			4,247	$297	9,165	626	20,097	1,354
Carp, Asiatic							100	8
Catfish and bullheads							377	34
Ciscoes—								
Fresh	2,390	$490	65,796	9,486	71,977	6,468	221,735	21,740
Salted			2,000	250			8,759	1,033
Eels			137	15			137	15
Pike	50	8	257	40	71	1	528	71
Pike perch—								
Blue pike	425	78	1,551	203	1,933	202	22,553	2,170
Wall-eyed or yellow pike	100	20	100	16	70	14	939	137
Rock bass							162	13
Sturgeon			2,240	620			6,077	1,458
Sturgeon caviar			125	400			125	400
Suckers	1,350	150	5,721	356	1,358	102	12,174	802
Sunfish			260	19			260	19
Trout, lake	300	42	12,146	1,388			22,628	2,687
Whitefish, common	3,500	700	20,154	2,285	4,195	652	81,464	10,814
Yellow perch	48	8	246	36	1,010	107	4,055	357
Total	8,163	1,496	114,980	16,011	89,779	8,172	402,170	43,112
Fyke nets:								
Bowfin			2,341	105	1,000	48	3,341	153
Carp, Asiatic			87	5	363	33	1,326	98
Catfish and bullheads			2,131	320	1,586	236	16,979	2,417
Ciscoes			4,433	783			4,433	783
Eels			390	32			10,727	1,004
Pike							5,364	733
Rock bass							260	59
Suckers			200	11	30	4	31,647	2,676
Sunfish			2,430	162	773	45	6,434	453
Yellow perch							8,801	447
Total			12,012	1,418	3,752	366	89,312	8,823
Seines:								
Burbot					40,000	1,000	40,000	1,000
Carp, Asiatic					7,686	327	13,706	644
Catfish and bullheads					550	44	680	60
Total					48,236	1,371	54,386	1,704
Lines:								
Catfish and bullheads							23	3
Ciscoes							5	1
Eels	227	25					460	41
Sturgeon	140	43	300	50	620	255	4,194	1,096
Sturgeon caviar							6	18
Total	367	68	300	50	620	255	4,688	1,159
Scap nets: Suckers							832	76
Grand total	8,530	1,564	127,292	17,479	241,503	18,323	910,686	83,700

FISHERIES OF ST. LAWRENCE RIVER.

The fisheries of the St. Lawrence River gave employment to 29 persons. The number of power and rowboats used was 26, valued at $1,180; the apparatus of capture used was set lines, valued at $620; and the investment amounted to $1,810. The products of the fisheries amounted to 22,169 pounds, valued at $5,324, of which 21,959 pounds were sturgeon, valued at $5,091, and 78 pounds sturgeon caviar, valued at $214.

Fisheries, by Counties.—The following table shows, by counties, the persons, investment, and quantity and value of the products of the fisheries of the St. Lawrence in 1917:

Persons Engaged, Investment, and Products, by Set Lines, in the Fisheries of the St. Lawrence River in 1917, by Counties.

Items.	Jefferson.		St. Lawrence.		Total.	
PERSONS ENGAGED.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
Fishermen	9		20		29	
INVESTMENT.						
Rowboats			20	$480	20	$480
Power boats	6	$700			6	700
Set lines		50		570		620
Shore and accessory property		10				10
Total	6	760	20	1,050	26	1,810
PRODUCTS BY SET LINES.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Eels			12	$3	12	$3
Pike			30	5	30	5
Pike perch (wall-eyed or yellow pike)			40	8	40	8
Sturgeon	3,867	$888	18,092	4,203	21,959	5,091
Sturgeon caviar	40	100	38	114	78	214
Yellow perch			50	3	50	3
Total	3,907	988	18,262	4,336	22,169	5,324

FISHERIES OF NIAGARA RIVER.

The fisheries of Niagara River are conducted in Erie and Niagara Counties, N. Y., and in 1917 gave employment to 60 persons. The number of power and rowboats used was 46, valued at $1,815; the apparatus of capture included 9 seines, valued at $495; 7 fishing machines, valued at $795; and set lines to the value of $441; and the value of the shore and accessory property was $300. The total investment amounted to $3,846. The yield of the fisheries of Niagara River was 116,603 pounds, valued at $11,420, of which 81,819 pounds, valued at $7,559, were taken with seines; 29,982 pounds, valued at $2,806, with fishing machines; and 4,802 pounds, valued at $1,055, with set lines. The principal species taken were: Ciscoes, 44,528 pounds, valued at $2,927; sturgeon, including caviar, 18,669 pounds, valued at $4,861; suckers, 17,285 pounds, valued at $967; carp, 15,890 pounds, valued at $822; and pike perch, 12,592 pounds, valued at $1,151.

Fisheries, by Counties.—The table following shows, by counties, the number of persons employed, investment, and quantity and value of the products of the fisheries of the Niagara River in 1917.

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS, BY APPARATUS, IN THE FISHERIES OF THE NIAGARA RIVER IN 1917, BY COUNTIES.

Items.	Erie.		Niagara.		Total.	
PERSONS ENGAGED.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
Fishermen	11		49		60	
INVESTMENT.						
Rowboats	11	$530	33	$735	44	$1,265
Power boats			2	550	2	550
Seines			9	495	9	495
Fishing machines			7	795	7	795
Set lines		234		207		441
Shore and accessory property				300		300
Total	11	764	51	3,082	62	3,846
PRODUCTS, BY APPARATUS.						
Seines:	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Carp, Asiatic			14,521	$744	14,521	$744
Catfish and bullheads			2,139	164	2,139	164
Ciscoes			32,860	2,059	32,860	2,059
Eels			436	64	436	64
Pike perch (blue pike)			7,980	742	7,980	742
Sturgeon	11,092	$2,755			11,092	2,755
Sturgeon caviar	160	320			160	320
Suckers			12,631	711	12,631	711
Total	11,252	3,075	70,567	4,484	81,819	7,559
Fishing machines:						
Carp, Asiatic			1,369	78	1,369	78
Catfish and bullheads			655	51	655	51
Ciscoes			11,668	868	11,668	868
Eels			1,109	83	1,109	83
Pike			340	51	340	51
Pike perch (blue pike)			4,603	408	4,603	408
Rock bass			50	5	50	5
Sturgeon			2,585	461	2,585	461
Sturgeon caviar			175	280	175	280
Suckers			4,560	251	4,560	251
Yellow perch			2,868	270	2,868	270
Total			29,982	2,806	29,982	2,806
Set lines:						
Catfish and bullheads			16	1	16	1
Eels			26	3	26	3
Pike perch (blue pike)			9	1	9	1
Sturgeon			4,657	1,045	4,657	1,045
Suckers			94	5	94	5
Total			4,802	1,055	4,802	1,055
Grand total	11,252	3,075	105,351	8,345	116,603	11,420

FISHERIES CONSIDERED BY STATES.

The States bordering on the Great Lakes and interested in the fisheries are: Minnesota, Wisconsin, Illinois, Indiana, Michigan, Ohio, Pennsylvania, and New York. Of these, Michigan borders on Lakes Superior, Michigan, Huron, St. Clair, and Erie; Wisconsin, on Lakes Superior and Michigan; and New York on Lakes Erie and Ontario. It is therefore of importance to consider these statistics by States, as well as by lakes.

In 1917 there were 9,221 persons engaged in the fisheries of the Great Lakes, of whom 3,183 are credited to Michigan, 1,909 to Wisconsin, 1,761 to Ohio, 683 to New York, 608 to Minnesota, 564 to Illinois, 446 to Pennsylvania, and 67 to Indiana. In Michigan the investment amounted to $2,937,086; Ohio, $2,462,832; Wisconsin, $1,668,529; Illinois, $1,265,664; Pennsylvania, $919,919; New York, $793,371; Minnesota, $428,443; and Indiana, $79,825. On the basis of the value of the products the States ranked as follows: Michigan, 29,737,355 pounds, valued at $2,035,889; Ohio, 26,442,993 pounds,

valued at $1,570,230; Wisconsin, 24,042,103 pounds, valued at $1,320,162; Pennsylvania, 8,151,241 pounds, valued at $508,382; Minnesota, 10,041,846 pounds, valued at $429,667; New York, 3,481,236 pounds, valued at $268,215; Illinois, 1,356,294 pounds, valued at $87,375; and Indiana, 1,016,155 pounds, valued at $75,099.

Separate statistics, by lakes, are given for States whose fisheries are conducted in more than one lake.

The following table shows, by States, the number of persons engaged, apparatus and capital employed, and products of the fisheries of the Great Lakes in 1917:

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS IN THE FISHERIES OF THE GREAT LAKES IN 1917, BY STATES.

Items.	New York.		Pennsylvania.		Ohio.	
PERSONS ENGAGED.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
On fishing vessels	82		247		188	
On vessels transporting	2		7		41	
In shore fisheries	451		47		1,171	
Shoresmen	148		145		361	
Total	683		446		1,761	
INVESTMENT.						
Vessels fishing:						
Steam	11	$79,000	36	$238,440	26	$151,958
Tonnage	236		812		652	
Outfit		10,230		43,684		39,765
Gasoline	5	8,700	9	18,200	6	12,000
Tonnage	38		93		55	
Outfit		1,180		3,276		3,540
Vessels transporting:						
Steam			1	3,000	4	21,500
Tonnage			23		88	
Outfit				250		4,950
Gasoline	1	1,300			19	41,600
Tonnage	10				193	
Outfit		65				9,455
Sail and row boats	202	5,125	17	765	516	24,810
Power boats	110	35,805	14	7,200	341	145,500
Apparatus, vessel fisheries: Gill nets	7,473	53,817	20,154	141,273	10,379	77,476
Apparatus, shore fisheries:						
Pound nets and trap nets	383	24,280	69	16,930	4,826	653,135
Gill nets	3,484	41,586	362	2,214	5,881	28,325
Fyke nets	334	4,374			523	27,160
Seines	20	850			219	33,097
Lines		1,872		8		45
Fishing machines	7	795				
Other apparatus		6				10
Shore and accessory property		387,500		366,679		993,506
Cash capital		136,886		78,000		195,000
Total		793,371		919,919		2,462,832
PRODUCTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Bowfin	7,046	$350			5,165	$69
Burbot	77,025	2,633	148,719	$1,541	488,886	6,241
Carp, Asiatic	70,980	3,743	22,427	718	4,589,118	214,120
Catfish and bullheads	48,629	6,016	990	61	626,847	39,090
Ciscoes:						
Fresh	2,503,723	173,076	7,381,256	447,744	7,735,136	465,983
Salted	8,909	1,051				
Eels	43,007	3,402				
Gold-eye, or moon-eye					10,335	104
Pike	16,191	2,149	1,238	148	4,428	402
Pike perch:						
Blue pike	65,374	6,453	162,878	13,049	1,874,551	120,523
Wall-eyed or yellow pike, fresh	8,388	1,177	3,214	412	1,211,574	139,877
Rock bass	7,625	468				
Sauger	77,598	3,879	33,993	2,245	3,817,581	233,911
Sheepshead or drum	355	26	10,863	309	2,844,633	69,190
Sturgeon	73,280	17,210	2,730	348	3,075	482
Sturgeon caviar	1,562	3,271				
Suckers, fresh	136,099	8,905	28,626	824	857,318	29,328
Sunfish	23,885	1,327				
Trout, lake, fresh	25,235	2,974	120	13	261	32
White bass	30	2	1,323	118	284,759	17,092
Whitefish, common, fresh	231,415	26,230	300,293	37,015	1,285,311	177,535
Yellow perch, fresh	54,880	3,873	52,571	3,837	804,015	56,251
Total	3,481,236	268,215	8,151,241	508,382	26,442,993	1,570,230

Persons Engaged, Investment, and Products in the Fisheries of the Great Lakes in 1917, by States—Continued.

Items.	Indiana.		Michigan.		Illinois.	
PERSONS ENGAGED.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
On vessels fishing	21		629		55	
On vessels transporting			65			
In shore fisheries	43		2,117		27	
Shoresmen	3		372		482	
Total	67		3,183		564	
INVESTMENT.						
Vessels fishing:						
Steam	2	$11,000	59	$203,450		
Tonnage	51		1,150			
Outfit		3,610		80,690		
Gasoline	1	1,200	93	91,250	13	$30,700
Tonnage	8		800		128	
Outfit		850		33,905		7,195
Vessels transporting:						
Steam			2	7,000		
Tonnage			24			
Outfit				500		
Gasoline			37	50,300		
Tonnage			365			
Outfit				7,215		
Sail and rowboats	23	610	741	17,153	9	195
Power boats	14	3,050	569	201,390	4	2,800
Apparatus vessel fisheries:						
Gill nets	1,695	35,940	37,584	356,624	2,355	20,225
Lines		200		11,143		
Apparatus, shore fisheries:						
Pound nets and trap nets	18	7,600	2,755	347,811	8	3,000
Gill nets	369	7,130	13,849	115,010	190	1,645
Fyke nets			795	35,773		
Seines			147	15,330		
Lines		60		4,829		35
Other apparatus				1,520		
Shore and accessory property		7,575		1,001,093		1,087,369
Cash capital		1,000		355,100		112,500
Total		79,825		2,937,086		1,265,664
PRODUCTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Bowfin			2,875	$174		
Burbot	3,139	$130	29,240	673	58	$1
Carp, Asiatic	1,150	46	2,636,159	105,929		
Catfish and bullheads	120	17	33,329	3,295		
Ciscoes:						
Fresh	813,830	52,713	7,361,794	333,736	1,015,818	54,140
Salted			2,621,018	118,554		
Smoked			3,000	120		
Muskellunge			145	15		
Pike	225	30	21,174	2,031		
Pike perch:						
Walle-yed or yellow pike, fresh	1,400	240	1,207,407	147,254		
Walle-yed or yellow pike, salted			30	3		
Rock bass			4,283	208		
Sheepshead or drum	750	30	28,146	1,027		
Sturgeon	2,396	680	13,735	2,987		
Sturgeon caviar	65	115	508	1,284		
Suckres:						
Fresh	3,190	132	3,049,569	123,107	5,265	200
Salted			3,815	144		
Sunfish			1,650	68		
Trout, lake:						
Fresh	123,410	13,226	7,188,617	647,208	168,640	18,112
Salted			9,203	822		
Trout, steelhead	21,250	3,232	700	117		
White bass			600	50		
Whitefish:						
Common fresh	4,130	722	4,102,926	450,706	33,600	4,750
Common, salted			5,295	531		
Common, caviar			1,375	257		
Menominee, fresh			124,374	6,177		
Menominee, salted			45,315	3,133		
Yellow perch:						
Fresh	41,100	3,786	1,239,348	86,198	132,913	10,172
Salted			1,725	81		
Total	1,016,155	75,099	29,737,355	2,035,889	1,356,294	87,375

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS IN THE FISHERIES OF THE GREAT LAKES IN 1917, BY STATES—Continued.

Items.	Wisconsin.		Minnesota.		Total.	
PERSONS ENGAGED.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
On vessels fishing	658		50		1,930	
On vessels transporting	48		48		211	
In shore fisheries	781		429		5,066	
Shoresmen	422		81		2,014	
Total	1,909		608		9,221	
INVESTMENT.						
Vessels fishing:						
Steam	51	$282,000	5	$11,500	190	$977,348
Tonnage	1,082		80		4,063	
Outfit		69,755		1,760		249,494
Gasoline	149	143,460	2	8,500	278	314,010
Tonnage	1,373		26		2,521	
Outfit		23,661		2,725		76,332
Vessels transporting:						
Steam			4	56,000	11	87,500
Tonnage			194		329	
Outfit				17,880		23,580
Gasoline	43	23,425	6	17,500	106	134,125
Tonnage	309		58		935	
Outfit		2,550		3,415		22,700
Sail and row boats	228	5,530	270	7,770	2,006	61,958
Power boats	177	60,600	119	18,460	1,348	474,805
Apparatus, vessel fisheries:						
Gill nets	24,020	219,273	222	5,175	103,882	909,803
Lines		19,194				30,537
Apparatus, shore fisheries:						
Pound nets and trap nets	369	126,000	5	500	8,433	1,179,256
Gill nets	20,345	62,176	4,915	69,813	49,395	327,899
Fyke nets	3,286	33,400			4,938	100,707
Seines	60	17,970			446	67,247
Lines		2,834		1,325		11,008
Crawfish pots	6,400	1,600			6,400	1,600
Fishing machines					7	795
Other apparatus						1,536
Shore and accessory property		451,301		183,120		4,478,143
Cash capital		123,800		23,000		1,025,286
Total		1,668,529		428,443		10,555,669
PRODUCTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Bowfin					15,086	$593
Burbot	136,522	$683			883,589	11,902
Carp, Asiatic	243,513	7,382			7,563,347	331,938
Catfish and bullheads	164,346	6,610			874,261	55,089
Ciscoes:						
Fresh	12,087,210	459,463	3,034,107	$96,389	41,932,874	2,083,244
Frozen			3,302,357	150,810	3,302,357	150,810
Salted	2,466,040	118,110	3,189,727	137,596	8,285,694	375,311
Smoked			5,400	432	8,400	552
Eels					43,007	3,402
Gold-eye, or moon-eye					10,335	104
Muskellunge					145	15
Pike	37,252	3,044			80,508	7,804
Pike perch:						
Blue pike					2,102,803	140,025
Wall-eyed or yellow pike, fresh	64,708	9,311			2,496,691	298,271
Wall-eyed or yellow pike, salted					30	3
Rock bass	1,714	137			13,622	813
Sauger					3,929,172	240,035
Sheepshead or drum	17,247	354			2,901,994	70,936
Sturgeon					95,216	21,707
Sturgeon caviar					2,135	4,670
Suckers:						
Fresh	1,224,346	40,072	27,055	1,078	5,331,468	203,646
Salted	27,145	1,091			30,960	1,235
Sunfish					25,535	1,395
Trout, lake:						
Fresh	5,369,971	563,641	405,135	34,079	13,281,389	1,279,285
Frozen			44,000	5,800	44,000	5,800
Salted	2,275	221	7,272	576	18,750	1,619
Trout, steelhead					21,950	3,349
White bass	675	27			287,387	17,289

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS IN THE FISHERIES OF THE GREAT LAKES IN 1917, BY STATES—Continued.

Items.	Wisconsin.		Minnesota.		Total.	
PRODUCTS—continued.						
Whitefish:	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Common, fresh	210,685	$23,393	17,093	$2,285	6,185,453	$722,636
Common, salted					5,295	531
Common, caviar					1,375	257
Menominee, fresh	27,695	1,131	6,800	394	158,869	7,702
Menominee, salted	805	40	2,900	228	49,020	3,401
Yellow perch:						
Fresh	1,879,459	81,025			4,204,286	245,142
Salted					1,725	81
Crawfish	80,495	4,427			80,495	4,427
Total	24,042,103	1,320,162	10,041,846	429,667	104,269,223	6,295,019

FISHERIES OF MICHIGAN.

The fisheries of Michigan which were prosecuted in Lakes Erie, St. Clair and tributaries, Huron, Michigan, and Superior, but which were most extensive in Lake Huron and Lake Michigan, are shown in detail in the following table:

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF MICHIGAN IN 1917, BY LAKES.

Items.	Lake Erie.		Lake St. Clair.[1]		Lake Huron.	
PERSONS ENGAGED.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
On vessels fishing	2				149	
On vessels transporting					29	
In shore fisheries	171		64		1,023	
Shoresmen	10		75		147	
Total	183		139		1,348	
INVESTMENT.						
Vessels fishing:						
Steam					13	$57,500
Tonnage					266	
Outfit						20,850
Gasoline	1	$1,300			13	19,000
Tonnage	5				113	
Outfit		10				6,140
Vessels transporting:						
Steam					2	7,000
Tonnage					24	
Outfit						500
Gasoline					19	33,500
Tonnage					169	
Outfit						4,750
Sail and row boats	56	1,435	60	$1,640	310	8,020
Power boats	28	7,440	4	900	260	103,960
Apparatus, vessel fisheries:						
Gill nets	4	51			6,613	69,575
Lines						3,844
Apparatus, shore fisheries:						
Pound nets and trap nets	86	8,175			1,731	207,904
Gill nets	6	65			3,997	33,260
Fyke nets	278	17,243			460	12,135
Seines	58	5,530	6	1,365	77	7,960
Lines				50		2,145
Other apparatus						1,520
Shore and accessory property		27,365		171,350		432,092
Cash capital		5,000		62,000		156,100
Total		73,614		237,305		1,188,705

[1] Includes St. Clair River and wholesale trade of Detroit.

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF MICHIGAN IN 1917, BY LAKES—Continued.

Items.	Lake Erie.		Lake St. Clair.		Lake Huron.	
PRODUCTS.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Bowfins					200	$4
Burbot					2,174	51
Carp, Asiatic	1,403,739	$57,731	85,330	$4,652	1,145,250	43,474
Catfish and bullheads					33,329	3,295
Ciscoes:						
Fresh	1,100	50			3,277,573	120,705
Salted					2,100,792	94,957
Smoked					3,000	120
Muskellunge					145	15
Pike					12,354	1,175
Pike perch:						
Wall-eyed or yellow pike—						
Fresh	70,870	8,155	48,000	7,200	994,642	119,231
Salted					30	3
Rock bass					4,283	208
Sheepshead or drum					17,731	615
Sturgeon	440	87			4,886	1,063
Sturgeon caviar					227	495
Suckers:						
Fresh	103,002	3,663			1,775,767	72,875
Salted					1,000	50
Sunfish					1,650	68
Trout, lake:						
Fresh					2,070,797	213,790
Salted					8,658	784
Whitefish:						
Common, fresh	27,275	3,701			993,501	124,050
Common, salted					3,350	330
Common, caviar					1,375	257
Menominee, fresh					46,457	2,191
Menominee, salted					20,017	1,200
Yellow perch, fresh	82,730	7,942			844,019	56,464
Total	1,689,156	81,329	133,330	11,852	13,363,207	857,470

Items.	Lake Michigan.		Lake Superior.		Total.	
PERSONS ENGAGED.	Number.	Value.	Number.	Value.	Number.	Value.
On vessels fishing	436		42		629	
On vessels transporting	33		3		65	
In shore fisheries	568		291		2,117	
Shoresmen	108		32		372	
Total	1,145		368		3,183	
INVESTMENT.						
Vessels fishing:						
Steam	43	$134,450	3	$11,500	59	$203,450
Tonnage	758		126		1,150	
Outfit		52,040		7,800		80,690
Gasoline	78	65,950	1	5,000	93	91,250
Tonnage	616		66		800	
Outfit		25,155		2,600		33,905
Vessels transporting:						
Steam					2	7,000
Tonnage					24	
Outfit						500
Gasoline	17	14,800	1	2,000	37	50,300
Tonnage	186		10		365	
Outfit		1,965		500		7,215
Sail and row boats	241	4,828	74	1,230	741	17,153
Power boats	168	48,295	109	40,795	569	201,390
Apparatus, vessel fisheries:						
Gill nets	29,833	267,728	1,134	19,270	37,584	356,624
Lines		6,739		560		11,143
Apparatus, shore fisheries:						
Pound nets and trap nets	787	114,420	151	17,312	2,755	347,811
Gill nets	6,416	51,367	3,430	30,318	13,849	115,010
Fyke nets	57	6,395			795	35,773
Seines	1	150	5	325	147	15,330
Lines		515		2,119		4,829
Other apparatus						1,520

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF MICHIGAN IN 1917, BY LAKES—Continued.

Items.	Lake Michigan.		Lake Superior.		Total.	
INVESTMENT—continued.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
Shore and accessory property		$258,236		$112,050		$1,001,093
Cash capital		127,000		5,000		355,100
Total		1,178,883		258,379		2,937,086
PRODUCTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Bowfins			2,675	$170	2,875	$174
Burbot	27,066	$622			29,240	673
Carp, Asiatic	1,840	72			2,636,159	105,920
Catfish and bullheads					33,329	3,295
Ciscoes:						
Fresh	3,159,135	173,810	923,986	39,171	7,361,794	333,736
Salted	519,726	23,574	500	23	2,621,018	118,554
Smoked					3,000	120
Muskellunge					145	15
Pike	8,020	776	800	80	21,174	2,031
Pike perch:						
Wall-eyed or yellow pike—						
Fresh	89,016	11,987	4,879	681	1,207,407	147,254
Salted					30	3
Rock bass					4,283	208
Sheepshead or drum	10,415	412			28,146	1,027
Sturgeon	8,409	1,837			13,735	2,987
Sturgeon caviar	281	789			508	1,284
Suckers:						
Fresh	995,552	39,453	175,248	7,116	3,049,569	123,107
Salted	2,815	94			3,815	144
Sunfish					1,650	68
Trout, lake:						
Fresh	3,580,969	306,044	1,536,851	127,374	7,188,617	647,208
Salted	545	38			9,203	822
Trout, steelhead	700	117			700	117
White bass	600	50			600	50
Whitefish:						
Common, fresh	2,839,868	298,594	242,262	24,361	4,102,906	450,706
Common, salted	1,945	201			5,295	531
Common, caviar					1,375	257
Menominee, fresh	76,687	3,876	1,230	110	124,374	6,177
Menominee, salted	25,298	1,933			45,315	3,133
Yellow perch:						
Fresh	309,599	21,557	3,000	235	1,239,348	86,198
Salted	1,725	81			1,725	81
Total	11,660,211	885,917	2,891,431	199,321	29,737,335	2,035,889

FISHERIES OF WISCONSIN.

The fisheries of Wisconsin which were prosecuted in Lakes Michigan and Superior are given in detail in the following table:

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF WISCONSIN IN 1917, BY LAKES.

Items.	Lake Michigan.		Lake Superior.		Total.	
PERSONS ENGAGED.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
On vessels fishing	584		74		658	
On vessels transporting	48				48	
In shore fisheries	647		134		781	
Shoresmen	258		164		422	
Total	1,537		372		1,909	
INVESTMENT.						
Vessels fishing:						
Steam	47	$252,200	4	$29,800	51	$282,000
Tonnage	986		96		1,082	
Outfit		68,235		1,520		69,755
Gasoline	148	136,460	1	7,000	149	143,460
Tonnage	1,361		12		1,373	
Outfit		23,436		225		23,661
Vessels transporting:						
Gasoline	43	23,425			43	23,425
Tonnage	309				309	
Outfit		2,550				2,550
Sail and row boats	155	4,310	73	1,220	228	5,530
Power boats	125	37,450	52	23,150	177	60,600
Apparatus:						
Vessel fisheries—						
Gill nets	23,570	211,723	450	7,550	24,020	219,273
Lines		18,794		400		19,194
Shore fisheries—						
Pound nets and trap nets	321	117,550	48	8,450	369	126,000
Gill nets	19,379	49,316	966	12,860	20,345	62,176
Fyke nets	3,286	33,400			3,286	33,400
Seines	60	17,970			60	17,970
Lines		1,465		1,369		2,834
Crawfish pots	6,400	1,600			6,400	1,600
Shore and accessory property		405,161		46,140		451,301
Cash capital		109,300		14,500		123,800
Total		1,514,345		154,184		1,668,529
PRODUCTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Burbot	136,522	$683			136,522	$683
Carp, Asiatic	243,513	7,382			243,513	7,382
Catfish and bullheads	164,346	6,610			164,346	6,610
Ciscoes:						
Fresh	10,352,805	425,975	1,734,405	$33,488	12,087,210	459,463
Salted	2,398,040	115,770	68,000	2,340	2,466,040	118,110
Pike	32,352	2,569	4,900	475	37,252	3,044
Pike perch (wall-eyed or yellow pike)	41,608	6,218	23,100	3,093	64,708	9,311
Rock bass	1,714	137			1,714	137
Sheepshead or drum	17,247	354			17,247	354
Suckers:						
Fresh	1,100,446	35,082	123,900	4,990	1,224,346	40,072
Salted	11,295	531	15,850	560	27,145	1,091
Trout, lake:						
Fresh	4,774,876	515,497	595,095	48,144	5,369,971	563,641
Salted	2,275	221			2,275	221
White bass	675	27			675	27
White fish:						
Common, fresh	167,830	19,096	42,855	4,297	210,685	23,393
Menominee, fresh	23,645	953	4,050	178	27,695	1,131
Menominee, salted	805	40			805	40
Yellow perch	1,877,459	8,904	2,000	121	1,879,459	9,025
Crawfish	80,495	4,427			80,495	4,427
Total	21,427,948	1,150,476	2,614,155	97,686	24,042,103	1,248,162

FISHERIES OF NEW YORK.

The fisheries of New York in the Great Lakes are conducted in Lake Ontario and the St. Lawrence and Niagara Rivers, and also in two counties, Erie and Chautauqua, on Lake Erie. The number of persons engaged, investment, and products of these fisheries are given in detail in the following table:

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF NEW YORK IN 1917, BY LAKES.

Items.	Lake Ontario.[1]		Lake Erie.		Total.	
PERSONS ENGAGED.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
On vessels fishing	2		80		82	
On vessels transporting	2				2	
In shore fisheries	363		88		451	
Shoresmen	11		137		148	
Total	378		305		683	
INVESTMENT.						
Vessels fishing:						
Steam			11	$79,000	11	$79,000
Tonnage			236		236	
Outfit				10,230		10,230
Gasoline	1	$1,200	4	7,500	5	8,700
Tonnage	8		30		38	
Outfit		20		1,160		1,180
Vessels transporting, gasoline	1	1,300			1	1,300
Tonnage	10				10	
Outfit		65				65
Sail and row boats	189	4,765	13	360	202	5,125
Power boats	79	17,130	31	18,675	110	35,805
Apparatus, vessel fisheries: Gill nets	3	40	7,470	53,777	7,473	53,817
Apparatus, shore fisheries:						
Pound nets and trap nets	353	21,460	30	2,820	383	24,280
Gill nets	162	15,135	3,322	26,451	3,484	41,586
Fyke nets	334	4,374			334	4,374
Seines	12	610	8	240	20	850
Lines		1,174		698		1,872
Fishing machines	7	795			7	795
Other apparatus		6				6
Shore and accessory property		50,235		337,265		387,500
Cash capital		20,000		116,886		136,886
Total		138,309		655,062		793,371
PRODUCTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Bowfin	7,046	$350			7,046	$350
Burbot	61,760	2,388	15,265	$245	77,025	2,633
Carp, Asiatic	41,472	2,173	29,508	1,570	70,980	3,743
Catfish and bullheads	47,934	5,935	695	81	48,629	6,016
Ciscoes:						
Fresh	460,363	39,991	2,043,360	133,085	2,503,723	173,076
Salted	8,909	1,051			8,909	1,051
Eels	43,007	3,402			43,007	3,402
Pike	16,191	2,149			16,191	2,149
Pike perch:						
Blue pike	45,730	4,784	19,644	1,669	65,374	6,453
Wall-eyed or yellow pike	2,590	458	5,798	719	8,388	1,177
Rock bass	7,525	463	100	5	7,625	468
Sauger			77,598	3,879	77,598	3,879
Sheepshead or drum	300	23	55	3	355	26
Sturgeon	51,141	12,063	22,139	5,147	73,280	17,210
Sturgeon caviar	544	1,232	1,018	2,045	1,562	3,277
Suckers	89,111	6,317	46,988	2,588	136,099	8,905
Sunfish	23,885	1,327			23,885	1,327
Trout	23,694	2,818	1,541	156	25,235	2,974
White bass			30	2	30	2
Whitefish	88,347	11,120	143,068	14,510	231,415	25,630
Yellow perch	34,839	2,819	20,041	1,654	54,880	4,473
Total	1,054,388	100,863	2,426,848	167,358	3,481,236	268,221

[1] Includes St. Lawrence and Niagara Rivers.

FISHERIES OF LAKE OF THE WOODS, RAINY LAKE, AND LAKES KABETOGAMA AND LA CROIX.

The number of persons engaged in the fisheries of Lake of the Woods, Rainy Lake, and Lakes Kabetogama and La Croix, Minn., in 1917 was 195, of whom 9 were on transporting vessels, 165 in the shore or boat fisheries, and 21 shoresmen.

The investment amounted to $177,210, which included 2 transporting vessels with their outfits, valued at $15,960, 82 sail and power boats, valued at $28,100; fishing apparatus to the value of $44,800; shore and accessory property, valued at $81,850; and cash capital utilized to the amount of $6,500. The fishing apparatus included 185 pound nets, valued at $36,250; 220 gill nets, valued at $8,150; and 30 fyke nets, valued at $400.

The products of the fisheries amounted to 2,167,169 pounds, valued at $118,508, which was divided among the different forms of apparatus as follows: Pound nets, 1,576,829 pounds, value $85,432; gill nets, 575,390 pounds, value $32,366; and fyke nets, 14,950 pounds, value $710. Among the principal species were pike perch, 706,279 pounds, valued at $67,615; pike, 553,037 pounds, valued at $22,109; ciscoes, 392,548 pounds, valued at $12,770; suckers, 268,980 pounds, valued at $3,584; whitefish, 96,185 pounds, valued at $8,095; and sturgeon, 13,820 pounds, valued at $1,659.

Following are given some comparative figures for Lake of the Woods for 1903 based on unpublished data and for 1917. In 1917 there were 100 men employed in the fisheries of this lake, an increase of 46 as compared with 1903. In 1903, the fishing apparatus consisted of 57 pound nets, valued at $17,100, as compared with 100 pound nets, valued at $15,000; 45 gill nets, valued at $1,500; and 30 fyke nets, valued at $400 in 1917. The products of the fisheries in 1903 amounted to 430,209 pounds, valued at $17,954, and in 1917 to 1,098,744 pounds, valued at $59,748, an increase of 668,535 pounds in quantity and of $41,794 in value.

The table following shows the extent of the fisheries of Lake of the Woods, Rainy Lake, and Lakes Kabetogama and La Croix, Minn., in 1917.

FISHERIES OF LAKE OF THE WOODS, RAINY LAKE, AND LAKES KABETOGAMA AND LA CROIX, MINN., 1917.

Items.	Lake of the Woods.		Rainy Lake and Lakes Kabetogama and La Croix.		Total.	
PERSONS ENGAGED.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
On vessels transporting	7		2		9	
In shore or boat fisheries	80		85		165	
Shoresmen	13		8		21	
Total	100		95		195	
INVESTMENT.						
Transporting vessels (steamers)	1	$8,300	1	$1,500	2	$9,800
Tonnage	20		9		29	
Value of outfit		5,760		400		6,160
Sail boats	3	800			3	800
Power boats	39	13,300	40	14,000	79	27,300
Pound nets	100	15,000	85	21,250	185	36,250
Gill nets	45	1,500	175	6,650	220	8,150
Fyke nets	30	400			30	400
Shore and accessory property		63,600		18,250		81,850
Cash capital		3,500		3,000		6,500
Total		112,160		65,050		177,210
PRODUCTS BY APPARATUS.						
Pound nets:	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Bullheads	5,400	$295			5,400	$295
Burbot	50,500	303	16,600	$250	67,100	553
Ciscoes ("Tullibee")	22,048	440	262,500	9,100	284,548	9,540
Gold-eye	38,865	583			38,865	583
Pike	191,537	6,989	188,600	7,500	380,137	14,489
Pike perch (wall-eyed or yellow pike)	335,279	30,475	200,000	20,000	535,279	50,475
Sturgeon	10,495	1,259	3,325	400	13,820	1,659
Suckers	160,180	2,119	30,000	375	190,180	2,494
Trout	130	9			130	9
Whitefish	45,135	3,985	15,000	1,200	60,135	5,185
Yellow perch	1,235	150			1,235	150
Total	860,804	46,607	716,025	38,825	1,576,829	85,432
Gill nets:						
Burbot	640	11			640	11
Ciscoes ("Tullibee")	20,500	630	87,500	2,600	108,000	3,230
Gold-eye	11,500	230			11,500	230
Pike	75,500	3,750	94,400	3,750	169,900	7,500
Pike perch (wall-eyed or yellow pike)	70,000	7,050	100,000	10,000	170,000	17,050
Suckers	43,800	650	30,000	375	73,800	1,025
Trout			2,500	200	2,500	200
Whitefish	1,050	110	35,000	2,800	36,050	2,910
Yellow perch			3,000	210	3,000	210
Total	222,990	12,431	352,400	19,935	575,390	32,366
Fyke nets:						
Bullheads	4,250	275			4,250	275
Crappie	100	10			100	10
Pike	3,000	120			3,000	120
Pike perch (wall-eyed or yellow pike)	1,000	90			1,000	90
Suckers	5,000	65			5,000	65
Yellow perch	1,600	150			1,600	150
Total	14,950	710			14,950	710
Grand total	1,098,744	59,748	1,068,425	58,760	2,167,169	118,508

FISHERIES OF THE GULF STATES IN 1918.

The information contained in this report applies to the commercial coast fisheries of the western coast of Florida, Alabama, Mississippi, Louisiana, and Texas, and is for the year 1918. The data were collected in 1919 by Winthrop A. Roberts and Rob Leon Greer, agents of this Bureau.

EARLIER PUBLICATIONS.

Some of the earlier publications relating to the fisheries of the Gulf States and published in Washington, D. C., follow:

Fisheries of the Gulf of Mexico, by Silas Stearns. The Fisheries and Fishery Industries of the United States, 1887, Section II, a Geographical Review of the Fisheries Industries and Fishing Communities for the Year 1880, pp. 533–587.

A Statistical Report on the Fisheries of the Gulf States, by J. W. Collins and H. M. Smith. Bulletin, U. S. Fish Commission, 1891, pp. 91–184.

Report on the Coast Fisheries of Texas, by Charles H. Stevenson. Appendix, Report of Commissioner, U. S. Commission of Fish and Fisheries, 1889–1891, pp. 373–420, pls. 13–27.

The Fish and Fisheries of the Coastal Waters of Florida. Transmitted to the United States Senate by the Commissioner of Fish and Fisheries, January 28, 1897. Senate Document 100, Fifty-fourth Congress, second session. See also pages 263–342, Appendix, Report of Commissioner, U. S. Commission of Fish and Fisheries, 1896.

Statistics of the Fisheries of the Gulf States, by C. H. Townsend. Report of Commissioner, U. S. Commission of Fish and Fisheries, 1899, pp. 105–169.

Statistics of the Fisheries of the Gulf States, 1902. Appendix, Report of Commissioner, U. S. Commission of Fish and Fisheries, 1903, pp. 411–481.

Fisheries of the United States, 1908. Special Reports, Bureau of the Census, 1911.

COMMON AND SCIENTIFIC NAMES OF FISHES OF GULF STATES.

To prevent misunderstanding from the use of the common names employed in the tables and discussions, the following list of common and scientific names of fishes is appended, the common name being the first given in every case. As the same common name is sometimes applied to more than one species of the same genus or species belonging to different genera, in such cases only the generic or family names are given, it being impossible to ascertain definitely the names of all the species represented in the catch. The names kingfish, whiting, sea mullet, sea mink, Virginia mullet, Carolina whiting, roundhead, hake, tom-cod, black mullet, etc., are applied to species of Menticirrhus. Most of these are used to designate other unrelated species, such as kingfish (*Scomberomorus regalis*) and whiting (*Merluccius bilinearis*), with resultant confusion. To avoid this confusion the Bureau has adopted the name king whiting for species of *Menticirrhus* in its reports, and suggests that the trade follow this practice in establishing a distinctive name for these important food fishes.

Amberfish	Seriola (species).
Angelfish	*Chætodipterus faber.*
Barracuda	Sphyræna (species).
Black drum	*Pogonias cromis.*
Bluefish	*Pomatomus saltatrix.*
Blue runner or hardtail	*Caranx crysos.*
Bonito	*Sarda sarda.*
Catfish	*Felichthys marinus.* *Galeichthys felis.*
Cero and kingfish	*Scomberomorus cavalla.* *Scomberomorus regalis.*

Cowfish and "shellfish"	Ostraciidæ (species).
Crevallé	Caranx (species).
Croaker	*Micropogon undulatus.*
Elops or ten-pounder	*Elops saurus.*
Flounders	Pleuronectidæ (species).
Groupers	Epinephelus (species). Mycteroperca (species). *Garrupa nigrita.*
Grunts	Hæmulidæ (species).
Hogfish	*Lachnolaimus maximus.*
Jewfish	*Promicrops guttatus.*
King whiting	Menticirrhus (species).
Leather jacket or "turbot"	*Balistes carolinensis.*
Menhaden	*Brevoortia tyrannus.*
Moonfish	*Vomer setipinnis.*
Mullet	*Mugil cephalus*; *Mugil curema.*
Permit	*Trachinotus goodei.*
Pigfish	*Orthopristis chrysopterus.*
Pompano	*Trachinotus carolinus.* Trachinotus (other species). (See also permit.)
Porgies	Calamus (species). Pagrus (species).
Porkfish	*Anisotremus virginicus.*
Redfish or red drum	*Sciaenops ocellatus.*
Sailors choice	Applied indiscriminately to several species.
Scamp	*Mycteroperca phenax.*
Sea bass	*Centropristes striatus.*
Sea gar	Tylosurus (species).
Sergeantfish or snook	*Centropomus undecimalis.*
Sharks	All Selachii except Batoidei.
Sheepshead	*Archosargus probatocephalus.*
Snapper, mangrove	*Lutianus griseus.*
Snapper, mutton	*Lutianus analis.*
Snapper, red	*Lutianus blackfordi.*
Spanish mackerel	*Scomberomorus maculatus.*
Spot	*Leiostomus xanthurus.*
Squeteagues or "sea trout"	*Cynoscion regalis.* *Cynoscion nothus.* *Cynoscion nebulosus.*
Sturgeon	*Acipenser sturio.*
Tang	Teuthididæ (species).
Tarpon	*Tarpon atlanticus.*
Yellowtail	*Ocyurus chrysurus.*

GENERAL STATISTICS.

The fisheries of the Gulf States in 1918 gave employment to 14,888 persons, of whom 1,731 were on vessels fishing, 297 on vessels transporting fishery products, 7,801 in shore fisheries, and 5,059 shoresmen in wholesale fish establishments, shrimp and oyster canneries, and other branches of the fishery industries. The west coast of Florida had 5,161 persons employed in its fisheries; Alabama, 783; Mississippi, 2,867; Louisiana, 4,191; and Texas, 1,886. Compared with the returns for 1902, the year for which the last canvass was made by the Bureau, there has been a decrease in the number of persons employed in all of the States except Texas, the total decrease being 3,141, or 17.42 per cent. The largest decrease was 1,477, or 34 per cent, in Mississippi. The increase in Texas was 742 persons, or 64.86 per cent. In this connection it will be recalled that during

the year 1918 large numbers of persons entered the military branches of the Government or engaged in other war activities, such as ship building.

The total amount of capital invested in the fisheries of these States in 1918 was $6,537,859. In Florida the investment was $2,404,245; in Alabama, $334,741; in Mississippi, $1,433,585; in Louisiana, $1,475,188; and in Texas, $890,100. There has been an increase of $1,830,399, or 38.88 per cent, in money invested in the fisheries of this region since 1902. The investment included 533 fishing and transporting vessels, valued at $1,259,840, and having a net tonnage of 8,655 net tons and outfits valued at $273,682; 6,642 boats, valued at $1,175,017; fishing apparatus used by vessels and boats, valued at $503,985; shore and accessory property to the value of $2,669,135; and cash capital to the amount of $656,200. The forms of fishing apparatus, arranged in order of value, are: Seines, 825, valued at $201,390; gill nets, 2,092, valued at $114,055; sponge apparatus to the value of $71,145; trammel nets, 516, valued at $44,910; tongs, 2,377, valued at $15,506; otter trawls, 422, valued at $13,755; lines to the value of $13,534; stop nets, 136, valued at $6,810; dredges, 198, valued at $5,950; and other apparatus to the value of $16,930. The use of the otter trawl, introduced in the shrimp fishery at Fernandina, Fla., about 1915, which is spreading rapidly along the Gulf coast, probably represents the most important change in apparatus since 1902.

The products of the fisheries in 1918 aggregated 130,923,583 pounds, valued at $6,510,310. Of this quantity, the west coast of Florida produced 54,753,639 pounds, valued at $3,420,363; Alabama, 5,609,219 pounds, valued at $230,567; Mississippi, 20,592,089 pounds, valued at $762,770; Louisiana, 24,953,876 pounds, valued at $1,419,367; and Texas, 25,014,760 pounds, valued at $677,243. The more important species taken in these States were black drum, 2,011,288 pounds, valued at $49,140; catfish, 851,265 pounds, valued at $40,072; croaker, 714,692 pounds, valued at $43,446; groupers, 5,935,825 pounds, valued at $235,406; menhaden, taken mostly in Texas, 14,392,920 pounds, valued at $109,939; mullet, including roe, 28,641,364 pounds, valued at $1,318,379; redfish, or red drum, 2,986,180 pounds, valued at $175,109; red snapper, 9,429,802 pounds, valued at $609,312; Spanish mackerel, 3,494,845 pounds, valued at $251,197; squeteagues, or "sea trout," 4,960,738 pounds, valued at $414,593; shrimp, green and dried, 27,142,999 pounds, valued at $1,098,427; crabs, 821,244 pounds, valued at $34,529; and oysters, 23,754,465 pounds, or 3,393,495 bushels, valued at $1,106,725.

Compared with the Bureau's returns for 1902, there has been an increase in the products of the fisheries of 17,226,613 pounds, or 15.15 per cent, in the quantity and of $3,016,114, or 86.31 per cent, in the value. Compared with the census returns for 1908, the increase amounts to 12,649,583 pounds, or 10.69 per cent, in quantity, and $1,650,310, or 33.95 per cent, in value.

Following are comparative figures of some of the more important species taken in the fisheries of the Gulf States in 1902 and 1918 for which there have been long-established fisheries: Catch of mullet, in 1902, 27,233,322 pounds, in 1918, 28,641,364 pounds; pompano, including permit, in 1902, 548,344 pounds, in 1918, 271,555 pounds;

redfish, or red drum, in 1902, 2,607,881 pounds, in 1918, 2,986,280 pounds; salt-water sheepshead, in 1902, 1,974,815 pounds, in 1918, 1,558,514 pounds; snappers, in 1902, 13,995,660 pounds, in 1918, 9,547,901 pounds; squeteagues, or "sea trout," in 1902, 4,789,047 pounds, in 1918, 4,960,738 pounds; and oysters, in 1902, 34,115,935 pounds, in 1918, 23,754,465 pounds. The total for these species for 1902 was 85,265,004 pounds, and for 1918, 71,720,817 pounds, a decrease of 13,544,187 pounds. It will be noted that the falling off is confined largely to the oyster industry, the catch of other products changing but little. The falling off in the oyster catch was probably due chiefly to loss of men to war activities and to transportation difficulties.

In connection with the above comparisons and with the efforts of the Bureau and other agencies to increase the use of fishery products, particularly the neglected forms, the following comparative figures for these years are of interest: Catch of black drum, in 1902, 418,875 pounds, in 1918, 2,011,288 pounds; crevalles, including blue runner, in 1902, 100,105 pounds, in 1918, 507,005 pounds; cero and kingfish, in 1902, 152,700 pounds, in 1918, 465,860 pounds; groupers, in 1902, 1,112,258 pounds, in 1918, 5,935,825 pounds; menhaden, in 1902, 12,500 pounds, in 1918, 14,413,942 pounds; Spanish mackerel, in 1902, 1,583,891 pounds, in 1918, 3,494,845 pounds; and shrimp, in 1902, 12,366,915 pounds, in 1918, 27,142,999 pounds. The total for these species for 1902 was 15,747,244 pounds, and for 1918, 53,971,757 pounds, an increase of 38,224,513 pounds.

The following tables give the comparative statistics for various years from 1890 to 1918 for (1) five important fisheries which have been long established, and (2) five fisheries of less importance, showing their development and increase in recent years.

COMPARATIVE STATISTICS OF PRODUCTS OF CERTAIN FISHERIES OF THE GULF STATES, VARIOUS YEARS, 1890 TO 1918.

Year.	Mullet.	Redfish.	Snappers.	Squeteagues.	Oysters.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
1890	15,185,117	2,160,767	4,527,920	2,959,433	20,587,098
1897	15,351,886	2,257,914	6,221,909	3,091,103	16,657,138
1902	27,233,322	2,607,881	13,995,660	4,789,047	31,115,935
1908	18,853,000	[1] 3,028,000	12,819,000	4,090,000	44,403,000
1918	28,641,364	2,986,280	9,547,901	4,960,738	23,754,465

Year.	Black drum.	Crevallés.[2]	Groupers.	Spanish mackerel.	Shrimp.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
1890	136,053	430,499	427,781	700,459	7,451,350
1897	117,825	93,640	853,618	726,676	6,791,025
1902	418,875	100,105	1,112,258	1,583,891	12,366,910
1908	....	276,000	1,625,000	1,486,000	12,561,001
1918	2,011,288	507,005	5,935,825	3,494,845	27,142,999

[1] Probably includes some black drum, for which no separate figures are given.
[2] Includes blue runner.

The following tables contain statistics of the number of persons employed, the amount of capital invested, the quantity and value of the products of the fisheries of the Gulf States in 1918, and comparative statistics of the products of the fisheries for various years;

also a comparison of the extent of the fisheries in 1902 and 1918 and comparative statistics of the oyster industry for various years from 1880 to 1918:

FISHERIES OF THE GULF STATES, 1918.

Items.	Florida (west coast only).		Alabama.		Mississippi.	
PERSONS ENGAGED.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
On vessels fishing	623		85		601	
On vessels transporting	70		33		66	
In shore fisheries	3,600		365		673	
Shoresmen	868		300		1,527	
Total	5,161		783		2,867	
INVESTMENT.						
Vessels fishing:						
Gasoline	33	$92,630	11	$31,600	10	$16,900
Tonnage	360		198		87	
Outfit		27,043		9,490		2,640
Sail	62	309,800	4	15,000	115	184,850
Tonnage	2,069		210		1,469	
Outfit		71,520		1,500		33,175
Vessels transporting:						
Gasoline	34	105,800	11	15,200	10	18,500
Tonnage	455		107		124	
Outfit		22,444		2,550		2,195
Sail	50	80,650	5	2,900	25	35,625
Tonnage	1,025		41		410	
Outfit				975		3,055
Boats, sail, row, etc	2,019	128,900	208	6,865	449	21,985
Boats, power	1,018	438,962	82	31,325	154	77,520
Apparatus, vessel fisheries:						
Seines	1	1,600			79	19,560
Trammel nets			8	600	8	800
Gill nets	6	120				
Lines		5,379		530		40
Otter trawls	16	720	3	120	2	50
Dredges					171	5,100
Tongs	12	120	3	22	8	48
Sponge apparatus		210				
Other apparatus		2				
Apparatus, shore fisheries:						
Seines	163	61,175	3	600	19	4,710
Trammel nets	146	11,990	138	9,710	89	8,900
Gill nets	1,795	106,070	6	50		
Stop nets	136	6,810				
Lines		2,016		90		363
Otter trawls	107	4,770	43	1,720	101	2,525
Tongs	284	2,616	224	1,680	365	1,825
Sponge apparatus		70,935				
Other apparatus		12,596		144		1,060
Shore and accessory property		619,987		178,170		786,109
Cash capital		219,350		23,900		206,050
Total		2,404,245		334,741		1,433,585
PRODUCTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Amberfish	11,100	$413			900	$45
Angelfish	20,825	798	6,900	$278		
Barracuda	4,860	232				
Black drum	57,420	1,735	12,200	593	13,777	507
Bluefish:						
Fresh	246,168	17,411	8,750	275	2,566	190
Salted	12,240	915				
Blue runner or hardtail:						
Fresh	324,648	6,935	11,000	330		
Salted	65,430	2,734				
Bonito	50,955	2,045				
Catfish	51,427	3,126	40,663	902	16,108	682
Cero and kingfish	465,860	31,903				
Cowfish and "shellfish"	300	12				
Crevalle	105,927	3,800				
Croaker			93,500	3,252	40,600	1,917
Elops, or ten-pounder:						
Fresh	267,940	5,402				
Salted	9,883	334				
Flounders	37,381	2,089	38,607	2,300	37,865	3,030
Groupers	5,626,329	222,215	244,000	10,485	24,656	863
Grunts	87,349	3,618	2,700	59		

FISHERIES OF THE GULF STATES, 1918—Continued.

Items.	Florida (west coast only).		Alabama.		Mississippi.	
PRODUCTS—continued.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Hogfish	7,344	$336				
Jewfish	69,844	2,704	2,000	$75	8,800	$288
King whiting	35,188	2,126	9,600	312	18,517	966
Leather jacket, or "turbot"	7,756	357				
Menhaden:						
Fresh	263,530	6,779			11,050	80
Salted	21,022	669				
Moonfish	650	23				
Mullet:						
Fresh	22,569,736	973,129	1,693,520	67,540	1,229,948	46,801
Salted	2,453,930	177,974	6,000	275	209,498	15,632
Mullet roe:						
Fresh			10	3		
Salted	86,285	17,593			13,985	1,829
Permit	7,865	294				
Pigfish	6,596	250				
Pompano:						
Fresh	235,992	27,262	4,966	799	4,289	688
Salted	3,075	520				
Porgies	56,742	2,442			1,400	49
Porkfish	2,400	144				
Redfish or red drum:						
Fresh	937,490	38,068	23,250	1,127	115,685	8,135
Salted	7,321	366				
Sailors choice	21,132	809				
Scamp	300	10				
Sea bass	31,644	2,180	600	30	4,380	360
Sergeantfish or snook	73,745	2,568				
Sharks			600	17	400	12
Sheepshead	988,662	32,627	28,050	1,465	67,612	4,482
Snapper:						
Mangrove	103,999	4,359				
Mutton	14,100	564				
Red	7,230,168	455,640	798,400	49,075	98,232	6,877
Spanish mackerel:						
Fresh	3,408,701	244,026	4,284	277	11,531	966
Salted	27,200	1,505				
Spot	37,977	1,519	41,700	1,423	19,090	774
Squeteagues, or "sea trout":						
Fresh	1,630,686	145,534	138,630	6,611	356,070	28,874
Salted	31,625	3,772				
Sturgeon	4,915	620	2,938	125		
Sturgeon caviar and roe	12	12	60	45		
Tang	600	30				
Tarpon	1,800	180				
Yellowtail	31,735	1,537				
Shrimp: Green	3,250,468	81,408	1,265,612	38,828	9,147,445	319,595
Sea crawfish	322,015	16,064				
Crabs:						
Hard			95,850	3,292	216,025	5,607
Soft					9,000	2,275
Stone	24,500	2,600				
Terrapin	2,475	206	2,938	1,104	5,600	3,900
Turtles	65,370	4,429			337	20
Clams, hard	160,872	14,336				
Oysters:						
Market, public	2,602,446	121,049	651,126	22,690	7,503,209	259,414
Market, private	13,496	771	190,575	15,485	1,403,514	47,912
Seed, public			190,190	1,495		
Conch	2,000	100				
Sponges:						
Glove	2,022	245				
Grass	73,033	12,125				
Sheepswool	276,168	675,781				
Wire	9,324	2,817				
Yellow	91,641	34,187				
Total	54,753,639	3,420,363	5,609,219	230,567	20,592,089	762,770

FISHERIES OF THE GULF STATES, 1918—Continued.

Items.	Louisiana.		Texas.		Total.	
PERSONS ENGAGED.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
On vessels fishing	65		357		1,731	
On vessels transporting	128				297	
In shore fisheries	2,093		1,070		7,801	
Shoresmen	1,905		459		5,059	
Total	4,191		1,886		14,888	
INVESTMENT.						
Vessels fishing:						
Steam			2	$50,000	2	$$50,000
Tonnage			217		217	
Outfit				14,800		14,800
Gasoline	16	$36,700	30	50,085	100	227,915
Tonnage	137		357		1,139	
Outfit		6,875		17,050		63,098
Sail	14	16,570	43	85,190	238	611,410
Tonnage	151		761		4,663	
Outfit		1,200		42,745		150,140
Vessels transporting:						
Gasoline	52	98,440			107	237,940
Tonnage	381				1,067	
Outfit		13,605				40,794
Sail	6	13,400			86	132,575
Tonnage	93				1,569	
Outfit		820				4,850
Boats, sail, row, etc	1,072	39,040	790	68,020	4,538	264,810
Boats, power	690	311,100	160	51,300	2,104	910,207
Apparatus, vessel fisheries:						
Seines	14	3,920	33	9,745	127	34,825
Trammel nets			3	260	19	1,660
Gill nets			6	90	12	210
Lines		20		1,075		7,041
Otter trawls	1	25			22	915
Dredges	25	750	2	100	198	5,950
Tongs	27	207	93	476	143	873
Sponge apparatus						210
Other apparatus				1		3
Apparatus, shore fisheries:						
Seines	316	71,955	197	28,125	698	166,565
Trammel nets	62	5,475	62	7,175	497	43,250
Gill nets			279	7,725	2,080	113,845
Stop nets					136	6,810
Lines		1,102		2,889		6,490
Otter trawls	149	3,825			400	12,840
Tongs	1,031	6,459	330	2,053	2,234	14,633
Sponge apparatus						70,935
Other apparatus		1,579		1,548		16,927
Shore and accessory property		671,621		413,248		2,669,135
Cash capital		170,500		36,400		656,200
Total		1,475,188		890,100		6,537,859
PRODUCTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Amberfish					12,000	$458
Angelfish	360	$18	124	$7	28,209	1,101
Barracuda					4,850	232
Black drum	54,455	1,911	1,873,436	44,394	2,011,288	49,140
Bluefish:						
Fresh			3,238	418	260,722	18,294
Salted					12,240	915
Blue runner or hardtail:						
Fresh					335,648	7,265
Salted					65,430	2,734
Bonito					50,955	2,045
Catfish	480,420	18,955	262,647	16,407	851,265	40,072
Cero and kingfish					465,860	31,903
Cowfish and "shellfish"					300	12
Crevalle					105,927	3,800
Croaker	383,035	28,862	197,557	9,415	714,692	43,446
Elops or ten-pounder:						
Fresh					267,940	5,402
Salted					9,883	334
Flounders	21,546	1,919	162,361	12,834	297,760	22,172
Groupers	20,000	1,000	20,840	843	5,935,825	235,406
Grunts			1,000	100	91,049	3,777

FISHERIES OF THE GULF STATES, 1918—Continued.

Items.	Louisiana.		Texas.		Total.	
PRODUCTS—continued.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Hogfish					7,344	$336
Jewfish			39,965	$2,514	120,609	5,581
King whiting			35,974	3,328	99,279	6,732
Leather jacket or "turbot"					7,756	357
Menhaden:						
Fresh			14,118,340	103,080	14,392,920	109,939
Salted					21,022	669
Moonfish					650	23
Mullet:						
Fresh	325,177	$15,794	53,275	1,809	25,871,656	1,105,073
Salted					2,669,428	193,881
Mullet roe:						
Fresh					10	3
Salted					100,270	19,422
Permit					7,865	294
Pigfish					6,596	250
Pompano:						
Fresh	820	184	14,548	2,007	260,615	30,940
Salted					3,075	520
Porgies					58,142	2,491
Porkfish					2,400	144
Redfish or red drum:						
Fresh	565,899	46,945	1,336,535	80,468	2,978,859	174,743
Salted					7,321	366
Sailors choice					21,132	809
Scamp					300	10
Sea bass	15,100	1,216	6,625	350	58,349	4,136
Sea gar:						
Fresh			80,887	4,697	80,887	4,697
Dried	6,500	455			6,500	455
Sergeantfish or snook					73,745	2,568
Sharks	2,000	60			3,000	89
Sheepshead	276,528	22,044	197,662	12,642	1,558,514	73,260
Snapper:						
Mangrove					103,999	4,359
Mutton					14,100	564
Red	60,000	4,000	1,243,002	93,720	9,429,802	609,312
Spanish mackerel:						
Fresh	1,775	226	41,354	4,197	3,467,645	249,692
Salted					27,200	1,505
Spot	66,625	3,330			165,392	7,046
Squeteagues or "sea trout":						
Fresh	1,190,357	110,474	1,613,370	119,328	4,929,113	410,821
Salted					31,625	3,772
Sturgeon					7,853	745
Sturgeon caviar and roe					72	57
Tang					600	30
Tarpon					1,800	180
Yellowtail	2,200	110			33,935	1,647
Shrimp:						
Green	12,571,861	442,480	164,067	8,791	26,399,453	891,102
Dried	743,546	207,325			743,546	207,325
Sea crawfish					322,015	16,064
Squid	560	56			560	56
Crabs:						
Hard	281,925	9,908	193,244	10,672	[1] 787,044	29,479
Soft			700	175	[2] 9,700	2,450
Stone					24,500	2,600
Terrapin	23,406	7,578	2,850	990	37,269	13,778
Turtles	4,360	218	6,671	447	76,738	5,114
Clams, hard					[3] 160,872	14,336
Oysters:						
Market, public	919,254	33,903	3,292,457	140,046	[4] 14,968,492	577,102
Market, private	6,936,167	460,396	52,031	3,564	[5] 8,595,783	528,128
Seed, public					[6] 190,190	1,495
Conch					2,000	100
Sponges:						
Glove					2,022	245
Grass					73,033	12,125
Sheepswool					276,168	675,785
Wire					9,324	2,811
Yellow					91,641	34,187
Total	24,953,876	1,419,367	25,014,760	677,243	130,923,583	6,510,310

[1] 2,361,132 in number.
[2] 29,100 in number.
[3] 20,109 bushels.
[4] 2,138,356 bushels.
[5] 1,227,969 bushels.
[6] 27,170 bushels.

COMPARATIVE STATISTICS OF PRODUCTS OF FISHERIES OF THE GULF STATES, VARIOUS YEARS, 1880 TO 1918.[1]

Years.	Florida (west coast only).		Alabama.		Mississippi.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
1880	8,376,335	$564,819	3,541,500	$119,275	788,500	$22,540
1887					6,548,175	189,716
1888	19,597,084	802,282	1,633,589	75,560	7,883,010	231,712
1889	23,597,240	918,845	4,560,269	146,841	8,933,339	250,884
1890	27,418,562	1,064,139	4,776,968	154,871	8,131,401	245,699
1897	28,255,219	944,793	4,699,381	134,438	7,829,685	192,298
1902	48,120,019	1,462,166	9,351,447	266,682	23,426,965	553,220
1908	37,566,000	2,120,000	10,665,000	387,000	17,302,000	459,000
1918	54,753,639	3,420,363	5,609,219	230,567	20,592,089	762,770

Years.	Louisiana.		Texas.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
1880	6,996,000	$392,610	3,858,875	$128,300	23,561,210	$1,227,544
1887	18,455,489	579,504	6,282,489	256,250		
1888	19,121,056	612,820	6,609,161	271,257	54,843,900	1,993,631
1889	20,947,239	621,048	7,357,800	297,258	65,395,887	2,264,876
1890	20,789,203	660,134	7,959,400	313,832	69,075,534	2,438,675
1897	17,401,788	713,587	7,174,550	286,610	65,360,623	2,271,726
1902	24,754,135	858,314	8,044,404	353,814	113,696,970	3,494,196
1908	42,302,000	1,448,000	10,439,000	446,000	118,274,000	4,860,000
1918	24,953,876	1,419,367	25,014,760	677,243	130,923,583	6,510,310

[1] The statistics for 1908 in this table are from data published by the Bureau of the Census.

COMPARATIVE STATISTICS OF EXTENT OF FISHERIES OF THE GULF STATES IN 1902 AND 1918.

States.	Persons engaged.				Capital invested.			
	1902	1918	Increase or decrease.		1902	1918	Increase.	
	Number.	*Number.*	*Number.*	*Per cent.*				*Per cent.*
Florida	6,416	5,161	−1,255	−19.56	$1,945,320	$2,404,245	$458,925	23.59
Alabama	1,098	783	− 315	−28.68	328,285	334,741	6,456	1.96
Mississippi	4,344	2,867	−1,477	−34.00	1,270,408	1,433,585	163,177	12.84
Louisiana	5,027	4,191	− 836	−16.63	789,723	1,475,188	685,465	86.79
Texas	1,144	1,886	+ 742	+64.86	373,724	890,100	516,376	138.17
Total	18,029	14,888	−3,141	−17.42	4,707,460	6,537,859	1,830,399	38.88

States.	Products.							
	Pounds.				Value.			
	1902	1918	Increase or decrease.		1902	1918	Increase or decrease.	
				Per cent.				*Per cent.*
Florida	48,120,019	54,753,639	+ 6,633,620	+ 13.78	$1,462,166	$3,420,363	+$1,958,197	+133.92
Alabama	9,351,447	5,609,219	− 3,742,228	− 40.01	266,682	230,567	− 36,115	− 13.54
Mississippi	23,426,965	20,592,089	− 2,834,876	− 12.10	553,220	762,770	+ 209,550	+ 37.87
Louisiana	24,754,135	24,953,876	+ 199,741	+ .80	858,314	1,419,367	+ 561,053	+ 65.36
Texas	8,044,404	25,014,760	+16,970,356	+210.95	353,814	677,243	+ 323,429	+ 91.41
Total	113,696,970	130,923,583	+17,226,613	+ 15.15	3,494,196	6,510,310	+3,016,114	+ 86.31

COMPARATIVE STATISTICS OF THE OYSTER INDUSTRY OF THE GULF STATES, VARIOUS YEARS, 1880 TO 1918.[1]

Years.	Florida.		Alabama.		Mississippi.	
	Bushels.	*Value.*	*Bushels.*	*Value.*	*Bushels.*	*Value.*
1880	58,600	$10,950	104,500	$44,950	25,000	$10,000
1887	(2)	(2)	(2)	(2)	581,100	118,974
1888	181,445	44,448	76,125	32,174	767,205	157,463
1889	294,871	75,189	438,425	96,758	845,503	167,713
1890	371,081	93,692	481,070	107,812	806,478	166,672
1895	170,518	46,308	(2)	(2)	(2)	(2)
1897	179,715	50,258	255,053	60,207	629,713	110,964
1902	579,587	124,108	347,460	119,773	2,405,132	426,222
1908	538,000	187,000	590,400	172,940	1,067,600	295,340
1911	187,462	109,472	441,917	72,742	657,670	140,420
1918	373,706	121,820	147,413	39,670	[3] 1,272,389	307,326

Years.	Louisiana.		Texas.		Total.	
	Bushels.	*Value.*	*Bushels.*	*Value.*	*Bushels.*	*Value.*
1880	295,000	$200,000	67,054	$47,300	550,154	$313,200
1887	678,227	215,163	256,199	88,275	(2)	(2)
1888	719,992	230,820	341,275	109,633	2,086,042	574,538
1889	835,520	269,057	360,600	111,400	2,774,919	720,117
1890	841,585	299,896	440,800	127,990	2,941,014	796,062
1895	(2)	(2)	(2)	(2)	(2)	(2)
1897	959,190	432,668	355,910	94,663	2,379,581	748,760
1902	1,198,413	493,227	343,113	100,359	4,873,705	1,263,689
1908	3,623,800	762,800	497,200	167,880	6,317,000	1,585,960
1911	4,504,402	1,022,723	434,690	131,609	6,226,141	1,476,966
1918	1,122,203	494,299	[4] 477,784	143,610	3,393,495	1,106,725

[1] The statistics for 1908 are from data published by the Bureau of the Census.
[2] Statistics not available.
[3] Includes 506,639 bushels, valued at $118,328, from private beds in Louisiana and 188,514 bushels, valued at $44,166, from public beds in Louisiana, all taken by Mississippi men.
[4] Includes 11,250 bushels, valued at $3,000, taken from Louisiana public beds by Texas men.

FISHERIES OF FLORIDA.

The statistics of the fisheries of Florida here presented are for the west or Gulf coast only. The fisheries of this part of Florida were more extensive than those of Alabama, Mississippi, and Louisiana combined. The number of persons employed was 5,161, of whom 623 were on vessels fishing, 70 on vessels transporting fishery products, 3,600 in the shore or boat fisheries, and 868 on shore in the wholesale fish establishments, in canneries, and other fishery industries.

The investment amounted to $2,404,245, which includes 95 fishing vessels, valued at $402,430, with a net tonnage of 2,429 tons, and outfits valued at $98,563; 84 transporting vessels, valued at $186,450, with a net tonnage of 1,480 tons, and outfits valued at $22,444; 1,018 power boats, valued at $438,962; 2,019 sail and other boats, valued at $128,900; fishing apparatus employed on vessels to the value of $8,151; fishing apparatus employed on boats to the value of $279,008; shore and accessory property valued at $619,987; and cash capital amounting to $219,350.

The products amounted to 54,753,639 pounds, valued at $3,420,363. This represents 41.82 per cent of the total quantity and 52.53 per cent of the total value of the products of the fisheries of the Gulf Coast States in 1918. Compared with 1902, there was an increase of 13.78 per cent in quantity and 133.92 per cent in value to the fishermen for the west coast of Florida. Among the products of special

importance were the following: Cero and kingfish, 465,860 pounds, valued at $31,903; groupers, 5,626,329 pounds, valued at $222,215; mullet, 25,109,951 pounds, valued at $1,168,696; redfish or red drum, 937,490 pounds, valued at $38,068; sheepshead, 988,662 pounds, valued at $32,627; red snapper, 7,230,168 pounds, valued at $455,640; Spanish mackerel, 3,435,901 pounds, valued at $245,531; squeteagues or "sea trout," 1,662,311 pounds, valued at $149,306; shrimp, 3,250,468 pounds, valued at $81,408; sea crawfish, 322,015 pounds, valued at $16,064; oysters, 2,615,942 pounds, or 373,706 bushels, valued at $121,820; and sponges, 452,188 pounds, valued at $725,155.

FISHERIES, BY COUNTIES.

The statistics as to the number of persons employed, investment, and products of the fisheries, by counties, of the west coast of Florida in 1918 are given in the following table:

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF FISHERIES OF WEST COAST OF FLORIDA IN 1918, BY COUNTIES.

Items.	Bay County.		Calhoun County.		Citrus County.		De Soto County.	
	Number.	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
PERSONS ENGAGED.								
On vessels fishing	20		2					
On vessels transporting							22	
In shore fisheries	335		20		130		274	
Shoresmen	26		6		17		72	
Total	381		28		147		368	
INVESTMENT.								
Vessels fishing:								
Gasoline	3	$15,000	1	$1,400				
Tonnage	63		7					
Outfit		7,323		50				
Vessels transporting:								
Gasoline							8	$39,500
Tonnage							138	
Outfit								16,000
Boats, sail, row, etc	59	1,705	4	100	130	$3,000	319	22,280
Boats, power	93	36,275	7	2,550	32	9,300	119	28,200
Apparatus, vessel fisheries:								
Lines		240						
Otter trawls			2	90				
Apparatus, shore fisheries:								
Seines	38	15,450	2	700			12	4,800
Gill nets	46	4,520	5	500	110	4,650	374	23,400
Stop nets							51	2,730
Lines		165				23		120
Tongs	13	104			8	56	4	36
Other apparatus		3						
Shore and accessory property		17,817		3,613		10,215		27,907
Cash capital		9,500		3,000		13,200		27,000
Total		108,102		12,003		40,444		191,973

Persons Engaged, Investment, and Products of Fisheries of West Coast of Florida in 1918, by Counties—Continued.

Items.	Bay County.		Calhoun County.		Citrus County.		De Soto County.	
PRODUCTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Angelfish					310	$14	5,256	$186
Black drum	275	$11			7,350	262	17,800	534
Bluefish:								
Fresh	72,243	4,305	23,468	$1,367	490	40	37,908	3,411
Salted	12,240	915						
Blue runner or hardtail:								
Fresh	165,315	2,482					600	24
Salted	65,430	2,734						
Bonito	25,897	1,036						
Catfish							22,000	990
Cero and kingfish							3,011	240
Crevalle					590	25	41,287	1,391
Elops or ten-pounder:								
Fresh	10,975	219					4,280	134
Salted	3,810	152						
Flounders	2,504	126	1,150	56	200	8	3,112	95
Groupers	327,736	13,358					20,992	712
Grunts	870	35					2,373	84
Hogfish							2,286	84
Jewfish	10,100	504					5,332	160
King whiting							2,481	215
Leather jacket or "turbot"	3,206	160						
Menhaden:								
Fresh	13,325	299						
Salted	4,360	174						
Moonfish	350	14						
Mullet:								
Fresh	302,999	13,627	133,575	5,281	1,120,219	50,372	5,629,366	231,136
Salted	896,626	68,213	77,840	4,800				
Mullet roe, salted	28,207	5,125	3,500	670				
Permit							3,773	135
Pigfish	650	26	100	4			2,000	65
Pompano:								
Fresh	10,678	1,654	3,030	456	250	50	121,893	11,867
Salted	3,075	520						
Porgies	33,957	1,358						
Redfish or red drum:								
Fresh	8,109	329	1,747	65	41,091	1,940	243,533	8,760
Salted	7,321	366						
Sailors choice					300	12	9,831	313
Scamp	300	10						
Sergeantfish or snook							27,840	900
Sheepshead	7,856	317	2,800	111	37,940	1,777	300,142	10,250
Snapper:								
Mangrove	970	38			7,930	317	34,249	1,268
Red	564,139	38,225					12,000	840
Spanish mackerel:								
Fresh	483,734	38,366	19,994	1,201			278,355	19,664
Salted	25,050	1,333						
Spot	1,570	63	550	16			6,420	210
Squeteagues or "sea trout":								
Fresh	110,157	11,103	19,237	1,493	101,083	9,216	483,167	43,574
Salted	1,125	112						
Yellowtail					1,500	60	1,527	49
Shrimp			15,741	354				
Oysters, market, public	11,760	630			35,000	2,000	7,560	450
Total	3,216,919	207,939	302,732	15,874	1,354,253	66,093	7,330,374	337,741

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF FISHERIES OF WEST COAST OF FLORIDA IN 1918, BY COUNTIES—Continued.

Items.	Escambia County.		Franklin County.		Hernando County.		Hillsborough County.	
PERSONS ENGAGED.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
On vessels fishing	339		75				57	
On vessels transporting							1	
In shore fisheries	152		284		8		63	
Shoresmen	79		533				10	
Total	570		892		8		131	
INVESTMENT.								
Vessels fishing:								
Gasoline	3	$11,000	16	$32,930			1	$1,500
Tonnage	33		151				8	
Outfit		2,200		8,463				410
Sail	35	263,800	2	8,600			9	21,000
Tonnage	1,667		30				189	
Outfit		52,860		3,032				3,540
Vessels transporting:								
Gasoline							1	500
Tonnage							6	
Outfit								45
Boats, sail, row, etc	25	645	68	2,585	4	$100	44	1,360
Boats, power	55	31,200	109	69,687	2	500	23	6,600
Apparatus, vessel fisheries:								
Lines		3,580		724				442
Otter trawls			14	630				
Tongs			12	120				
Apparatus, shore fisheries:								
Seines	8	2,400	24	14,400			7	1,275
Gill nets	16	1,335	41	3,960	8	400	48	2,450
Trammel nets	29	2,900						
Stop nets							16	730
Otter trawls	9	360	98	4,410				
Lines		150		198				20
Tongs	14	117	205	2,025				
Other apparatus				10				
Shore and accessory property		75,611		219,740		100		12,925
Cash capital		15,700		77,150				7,000
Total		463,858		448,664		1,100		59,827
PRODUCTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Amberfish	9,000	$328	100	$5				
Angelfish	1,700	74			50	$2	485	$20
Black drum	2,000	80	600	19			1,050	31
Bluefish, fresh	31,710	1,902	14,171	820			50	4
Blue runner or hardtail, fresh	52,130	1,302	7,500	200				
Bonito	22,000	880						
Catfish			27,156	2,040				
Crevalle	18,000	720			290	12	2,456	118
Elops or ten pounder, fresh	138,000	2,760	37,000	700				
Flounders	7,300	365	8,142	537			600	31
Groupers	3,120,294	123,214	743,022	32,855			192,181	7,783
Grunts			3,350	144				
Jewfish	32,850	1,223	1,000	45				
King whiting	14,000	760	2,400	128			300	18
Leather jacket or "turbot"	2,600	104						
Menhaden, fresh	194,270	4,856	5,758	120				
Mullet:								
Fresh	615,095	36,905	620,713	29,578	198,000	7,920	830,243	34,761
Salted			113,020	9,251				
Mullet roe, salted			5,025	1,134				
Pigfish	2,000	80					135	6
Pompano, fresh	9,703	1,455	877	111			2,070	306
Porgies	9,885	364	3,200	138				
Redfish or red drum, fresh	16,000	640	13,049	584	4,570	182	28,500	1,165
Sea bass			720	48				
Sergeantfish or snook							7,700	352
Sheepshead	17,000	680	1,250	56	1,950	78	4,300	175
Snapper:								
Mangrove					298	12	11,810	544
Red	4,661,984	286,434	655,716	43,409			353,247	22,868
Spanish mackerel, fresh	124,076	8,065	53,809	3,219				
Spot	7,500	330	1,250	29			1,800	86
Squeteagues or "sea trout," fresh	17,802	1,957	40,718	3,152	4,980	398	35,300	2,424
Sturgeon	2,250	270	1,215	60				
Yellowtail	8,000	320					2,200	112
Shrimp	28,526	1,711	3,206,201	79,343				
Turtles	5,000	250						
Oysters, market, public	53,536	3,824	2,387,021	107,112				
Total	9,224,211	481,853	7,953,983	314,837	210,138	8,604	1,474,427	70,804

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF FISHERIES OF WEST COAST OF FLORIDA IN 1918, BY COUNTIES—Continued.

Items.	Jefferson County.		Lafayette County.		Lee County.		Levy County.	
PERSONS ENGAGED.	*Number*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
On vessels transporting					19			
In shore fisheries	10		26		274		138	
Shoresmen					53		15	
Total	10		26		346		153	
INVESTMENT.								
Vessels transporting:								
Gasoline					9	$37,000		
Tonnage					126			
Outfit						2,974		
Boats, sail, row, etc	10	$200	26	$545	240	7,520	109	$3,060
Boats, power	5	500	1	900	114	18,850	43	19,350
Apparatus, shore fisheries:								
Seines					14	5,600		
Gill nets	10	400	26	1,040	304	15,800	101	3,815
Trammel nets							45	2,450
Lines						42		200
Tongs					3	12	10	70
Other apparatus								12,000
Shore and accessory property		200		250		108,502		17,267
Cash capital						12,000		6,000
Total		1,300		2,735		208,300		64,212
PRODUCTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Angelfish					5,909	$202	1,800	$90
Black drum					5,675	135	5,500	225
Bluefish, fresh					16,765	1,508	6,200	496
Blue runner or hardtail, fresh					300	12	57,530	1,726
Catfish					1,000	45		
Crevalle					27,849	906	3,200	160
Elops or ten pounder, fresh					1,000	30		
Flounders					1,258	39	2,150	172
Groupers					3,571	117	231,930	8,277
Grunts					798	27	17,250	517
Hogfish					833	27		
Jewfish					11,280	226		
King whiting					2,047	180	6,800	408
Menhaden, fresh							10,000	500
Mullet:								
Fresh	72,000	$3,600	154,350	$7,718	3,930,564	156,226	1,200,154	60,008
Salted	31,500	2,205	72,615	5,083			5,000	350
Mullet roe, salted	1,230	230	1,250	250			1,700	340
Permit					1,592	51		
Pigfish					311	10		
Pompano, fresh					32,557	3,689	2,365	356
Redfish or red drum, fresh	850	42	4,150	208	156,759	5,115	173,855	8,693
Sailors choice					2,273	73	500	25
Sea bass							29,924	2,092
Sergeantfish or snook					14,292	428		
Sheepshead	230	11	2,000	100	304,068	9,880	142,539	2,128
Snapper:								
Mangrove			900	45	7,879	258	1,600	80
Red							3,000	240
Spanish mackerel, fresh					57,971	4,056	23,950	1,919
Spot					7,667	250	5,000	250
Squeteagues or "sea trout," fresh	1,200	96	8,000	640	255,255	21,192	56,967	4,557
Sturgeon							1,450	290
Sturgeon caviar							12	12
Yellowtail					658	20		
Terrapin							2,475	206
Turtles							8,500	620
Clams, hard					159,272	13,936		
Oysters, market:								
Public					10,500	600	35,840	2,048
Private							13,496	771
Total	107,010	6,184	243,265	14,044	5,019,903	219,238	2,050,687	97,556

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF FISHERIES OF WEST COAST OF FLORIDA IN 1918, BY COUNTIES—Continued.

Items.	Manatee County.		Monroe County.		Okaloosa County.		Pasco County.	
PERSONS ENGAGED.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*	*Number*	*Value.*
On vessels fishing			95					
On vessels transporting	2		10					
In shore fisheries	234		322		109		30	
Shoresmen	26		31					
Total	262		458		109		30	
INVESTMENT.								
Vessels fishing:								
Gasoline			7	$15,800				
Tonnage			74					
Outfit				3,500				
Sail			13	7,800				
Tonnage			121					
Outfit				9,360				
Vessels transporting:								
Gasoline	1	$1,500	7	13,200				
Tonnage	8		104					
Outfit		150		1,250				
Boats, sail, row, etc	193	5,970	231	23,375	57	$1,175	19	$475
Boats, power	93	23,350	82	49,550	33	14,600	8	2,500
Apparatus, vessel fisheries:								
Seines			1	1,600				
Gill nets			6	120				
Dip nets			2	2				
Lines				43				
Sponge apparatus				210				
Apparatus, shore fisheries:								
Seines	32	9,025			7	2,800		
Gill nets	291	19,380	51	6,870	6	450	30	1,500
Trammel nets					25	2,500		
Stop nets	59	2,850						
Dip nets			20	20				
Lines		68		470				
Tongs	6	36						
Other apparatus		3		552				
Shore and accessory property		17,100		56,287		750		100
Cash capital		15,500		14,000				
Total		94,932		204,009		22,275		4,575
PRODUCTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds*	*Value.*
Amberfish			2,000	$80				
Angelfish	2,000	$80	800	48				
Barracuda			4,860	232				
Black drum	14,890	357	500	10	280	$11		
Bluefish, fresh	10,184	951	16,614	1,540	12,958	778	550	$44
Blue runner or hardtail, fresh			11,000	420	29,673	742		
Bonito			350	21	2,708	108		
Catfish					1,271	51		
Cero and kingfish	42,367	2,542	394,945	27,619				
Cowfish and "shellfish"			300	12				
Crevalle	5,732	229	300	15	878	35	275	10
Elops or ten-pounder:								
Fresh	3,725	100			72,752	1,455		
Salted					6,073	182		
Flounders	2,930	118			600	30		
Groupers	24,280	961	54,144	2,889				
Grunts	7,287	219	30,300	1,698				
Hogfish	325	13	2,700	162				
Jewfish			9,000	540				
King whiting	3,945	234			3,215	183		
Leather jacket or "turbot"			1,500	75				
Menhaden:								
Fresh					40,177	1,004		
Salted					16,662	495		
Moonfish			300	9				
Mullet:								
Fresh	3,250,926	143,800	112,313	4,531	201,688	12,101	863,000	36,655
Salted					456,459	36,516		

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF FISHERIES OF WEST COAST OF FLORIDA IN 1918, BY COUNTIES—Continued.

Items.	Manatee County.		Monroe County.		Okaloosa County.		Pasco County.	
PRODUCTS—continued.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Permit	600	$24	1,400	$64				
Pigfish	1,400	59						
Pompano, fresh	28,343	3,665	545	101	8,909	$1,336		
Porgies			9,700	582				
Porkfish			2,400	144				
Redfish or red drum, fresh	191,020	7,840	100	3	2,893	116	2,925	$128
Sailors choice	1,028	41	2,200	110				
Sergeantfish or snook	15,913	578						
Sheepshead	133,850	5,566	300	12	3,701	148	875	35
Snapper:								
Mangrove	18,513	739	9,500	550			980	39
Mutton			14,100	564				
Red			9,000	630				
Spanish mackerel:								
Fresh	147,463	12,884	2,065,276	144,610	145,147	9,436		
Salted					2,150	172		
Spot	1,840	79			450	22		
Squeteagues or "sea trout":								
Fresh	182,338	17,686			51,450	5,163	8,635	691
Salted					30,500	3,660		
Tang			600	30				
Tarpon			1,800	180				
Yellowtail	5,350	226	12,500	750				
Sea crawfish			322,015	16,064				
Crabs, stone	2,000	100						
Turtles			49,250	3,398	1,920	96		
Clams, hard	1,600	400						
Oysters, market, public	875	75						
Conch			2,000	100				
Sponges:								
Glove			2,022	245				
Grass			28,963	3,311				
Sheepswool			55,281	73,012				
Yellow			21,477	5,809				
Total	4,100,724	199,[illegible]66	3,752,355	290,170	1,092,514	73,840	877,240	37,602

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF FISHERIES OF WEST COAST OF FLORIDA IN 1918, BY COUNTIES—Continued.

Items.	Pinellas County.		Santa Rosa County.		Taylor County.	
PERSONS ENGAGED.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
On vessels fishing	35					
On vessels transporting	16					
In shore fisheries	942		32		45	
Total	993		32		45	
INVESTMENT.						
Vessels fishing:						
Gasoline	2	$15,000				
Tonnage	24					
Outfit		5,067				
Sail	3	8,600				
Tonnage	62					
Outfit		2,728				
Vessels transporting:						
Gasoline	8	11,100				
Tonnage	73					
Outfit		2,025				
Sail	50	80,650				
Tonnage	1,025					
Boats, sail, row, etc	330	51,675	9	$225	45	$900
Boats, power	152	114,100	16	2,850	10	1,400
Apparatus, vessel fisheries, lines		350				
Apparatus, shore fisheries:						
Seines	12	3,400				
Gill nets	191	10,150			45	1,800
Trammel nets	16	1,600	9	1,000		
Stop nets	10	500				
Lines		590				
Tongs	1	5	20	155		
Sponge apparatus		70,935				
Other apparatus		8				
Shore and accessory property		46,128		150		1,150
Cash capital		16,500				300
Total		444,111		4,380		5,550
PRODUCTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Angelfish	2,365	$75				
Bluefish, fresh	2,507	213				
Cero and kingfish	25,537	1,502				
Crevalle	4,020	131				
Elops or ten-pounder, fresh	208	4				
Flounders	3,535	158	300	$30		
Groupers	908,179	32,049				
Grunts	25,121	894				
Hogfish	1,000	40	200	10		
Jewfish	282	6				
Leather jacket or "turbot"	450	18				
Mullet:						
Fresh	2,598,083	103,546	120,000	6,000	285,850	$13,227
Salted			9,000	720	133,120	9,317
Mullet roe, salted					5,975	925
Permit	500	20				
Pompano, fresh	14,772	2,216				
Redfish or red drum, fresh	27,959	1,293	1,000	50	8,150	410
Sailors choice	4,600	217				
Sea bass	1,000	40				
Sergeantfish or snook	8,000	310				
Sheepshead	18,456	860	1,800	90	1,955	98
Snapper:						
Mangrove	8,470	428				
Red	971,082	62,994				
Spanish mackerel, fresh	8,176	538				
Spot	1,580	69	1,500	75	350	17
Squeteagues or "sea trout," fresh	144,323	12,108	25,000	2,500	10,220	818
Crabs, stone	22,500	2,500				
Oysters, market, public	4,354	310	56,000	4,000		
Sponges:						
Grass	44,070	8,814				
Sheepswool	220,887	602,769				
Wire	9,324	2,817				
Yellow	70,164	28,378				
Total	5,151,504	865,317	214,800	13,475	445,620	24,812

Persons Engaged, Investment, and Products of Fisheries of West Coast of Florida in 1918, by Counties—Continued.

Items.	Wakulla County.		Walton County.		Total.	
PERSONS ENGAGED.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
On vessels fishing					623	
On vessels transporting					70	
In shore fisheries	169		3		3,600	
Shoresmen					868	
Total	169		3		5,161	
INVESTMENT.						
Vessels fishing:						
Gasoline					33	$92,630
Tonnage					360	
Outfit						27,043
Sail					62	309,800
Tonnage					2,069	
Outfit						71,520
Vessels transporting:						
Gasoline					34	105,800
Tonnage					455	
Outfit						22,444
Sail					50	80,650
Tonnage					1,025	
Boats, sail, row, etc	96	$1,980	1	$25	2,019	128,900
Boats, power	20	6,500	1	200	1,018	438,962
Apparatus, vessel fisheries:						
Seines					1	1,600
Gill nets					6	120
Dip nets					2	2
Lines						5,379
Otter trawls					16	720
Tongs					12	120
Sponge apparatus						210
Apparatus, shore fisheries:						
Seines	6	1,200	1	125	163	61,175
Gill nets	92	3,650			1,795	106,070
Trammel nets	22	1,540			146	11,990
Stop nets					136	6,810
Otter trawls					107	4,770
Dip nets					20	20
Lines						2,046
Tongs					284	2,616
Sponge apparatus						70,935
Other apparatus						12,576
Shore and accessory property		4,175				619,987
Cash capital		2,500				219,350
Total		21,545		350		2,404,245
PRODUCTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Amberfish					11,100	$413
Angelfish	150	$7			20,825	798
Barracuda					4,860	232
Black drum	1,500	60			57,420	1,735
Bluefish:						
Fresh	350	32			246,168	17,411
Salted					12,240	915
Blue runner or hardtail:						
Fresh	600	27			324,648	6,935
Salted					65,430	2,734
Bonito					50,955	2,045
Catfish					51,427	3,126
Cero and kingfish					465,860	31,903
Cowfish and "shellfish"					300	12
Crevalle	1,050	48			105,927	3,800
Elops or ten-pounder:						
Fresh					267,940	5,402
Salted					9,883	334
Flounders	3,600	324			37,381	2,089
Groupers					5,626,329	222,215
Grunts					87,349	3,618
Hogfish					7,344	336
Jewfish					69,844	2,704
King whiting					35,188	2,126
Leather jacket or "turbot"					7,756	357

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF FISHERIES OF WEST COAST OF FLORIDA IN 1918, BY COUNTIES—Continued.

Items.	Wakulla County.		Walton County.		Total.	
PRODUCTS—continued.						
Menhaden:	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Fresh					263,530	$6,779
Salted					21,022	669
Moonfish					650	23
Mullet:						
Fresh	321,598	$15,597	9,000	$540	22,569,736	973,129
Salted	658,750	41,519			2,453,930	177,974
Mullet roe, salted	39,398	8,919			86,285	17,593
Permit					7,865	294
Pigfish					6,596	250
Pompano:						
Fresh					235,992	27,262
Salted					3,075	520
Porgies					56,742	2,442
Porkfish					2,400	144
Redfish or red drum:						
Fresh	11,230	505			937,490	38,068
Salted					7,321	366
Sailors choice	400	18			21,132	809
Scamp					300	10
Sea bass					31,644	2,180
Sergeantfish or snook					73,745	2,568
Sheepshead	5,650	255			988,662	32,627
Snapper:						
Mangrove	900	41			103,999	4,359
Mutton					14,100	564
Red					7,230,168	455,640
Spanish mackerel:						
Fresh	750	68			3,408,701	244,026
Salted					27,200	1,505
Spot	500	23			37,977	1,519
Squeteagues or "sea trout":						
Fresh	71,854	6,466	3,000	300	1,630,686	145,534
Salted					31,625	3,772
Sturgeon					4,915	620
Sturgeon caviar					12	12
Tang					600	30
Tarpon					1,800	180
Yellowtail					31,735	1,537
Shrimp					3,250,468	81,408
Sea crawfish					322,015	16,064
Crabs, stone					[1] 24,500	2,600
Terrapin					2,475	206
Turtles	600	60	100	5	65,370	4,429
Clams, hard					[2] 160,872	14,336
Oysters, market:						
Public					[3] 2,602,446	121,049
Private					[4] 13,496	771
Conch					2,000	100
Sponges:						
Glove					2,022	245
Grass					73,033	12,125
Sheepswool					276,168	675,781
Wire					9,324	2,817
Yellow					91,641	34,187
Total	1,118,880	73,969	12,100	845	54,753,639	3,420,363

[1] Represents 18,375 in number.
[2] Represents 20,109 bushels.
[3] Represents 371,778 bushels.
[4] Represents 1,928 bushels.

FISHERIES, BY APPARATUS.

In the vessel fisheries of western Florida, in which seven counties are represented, the forms of apparatus in use included haul seines, gill nets, otter trawls, lines, dip nets, sponge apparatus, and oyster tongs. The total yield from all forms of apparatus used on vessels was 10,941,646 pounds, valued at $605,899. The catch with lines was 10,276,677 pounds, valued at $546,040, of which 6,011,297 pounds, valued at $373,124, were red snapper, and 4,162,160 pounds, valued at $167,977, were groupers. The catch of shrimp with otter trawls, which are rapidly supplanting haul seines in this fishery, amounted to 343,219 pounds, with a value of $8,701. Bluefish, mullet, pompano, and Spanish mackerel were taken with seines to the amount of 133,848 pounds, valued at $9,374; oysters with tongs, 76,461 pounds, valued at $4,822; sponges with sponge apparatus, 43,191 pounds, valued at $32,952; turtles with gill nets, 40,250 pounds, valued at $2,610, and sea crawfish with dip nets, 28,000 pounds, valued at $1,400. Vessel operations with seines, gill nets, dip nets, and sponge apparatus were confined to Monroe County.

In the shore or boat fisheries, gill nets were the most productive form of apparatus, the catch amounting to 20,068,013 pounds, valued at $1,009,315. Mullet was the principal species taken, amounting to 15,340,486 pounds, valued at $674,949. The catch with seines was 8,535,648 pounds, valued at $440,971. The mullet is again the principal species, other important species being Spanish mackerel, squeteagues, and sheepshead.

As in 1902, the stop-net fisheries ranked third in quantity of products, the catch amounting to 3,632,397 pounds, valued at $151,077. The principal species taken in this fishery were mullet, redfish, and sheepshead. The catch with lines was 3,582,153 pounds, valued at $195,560, the principal species taken by this apparatus being red snapper and groupers. The catch with otter trawls, confined to shrimp, was 2,907,249 pounds, valued at $72,707; of oysters with tongs, 2,539,481 pounds, valued at $116,998; with trammel nets made up of miscellaneous species, 1,499,550 pounds, valued at $95,334; of sponges with sponge apparatus, 408,997 pounds, valued at $692,203; of sea crawfish with dip nets, 283,915 pounds, valued at $14,164; and with other minor apparatus, 354,590 pounds, valued at $26,135. The total yield from all forms of apparatus used in the shore or boat fisheries was 43,811,993 pounds, valued at $2,814,464.

The products of the vessel and shore or boat fisheries are shown separately by counties in the following tables:

YIELD OF VESSEL FISHERIES OF WEST COAST OF FLORIDA IN 1918, BY COUNTIES, APPARATUS, AND SPECIES.

Apparatus and species.	Bay.		Calhoun.		Escambia.		Franklin.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Otter trawls: Shrimp			15,741	$354			327,478	$8,347
Lines:								
Amberfish					9,000	$328	100	5
Groupers	189,091	$7,466			3,081,257	122,070	621,075	27,851
Grunts	870	35					3,350	144
Jewfish	10,100	504			32,000	1,189	1,000	45
King whiting							300	12
Leatherjacket or "turbot"					2,000	80		
Porgies	1,050	42			9,200	340	2,650	116
Scamp	300	10						
Sea bass							450	29
Snapper: Red	216,461	15,626			4,580,077	281,732	563,326	36,966
Total	417,872	23,683			7,713,534	405,739	1,192,251	65,168
Tongs: Oysters, market, public							76,461	4,822
Grand total	417,872	23,683	15,741	354	7,713,534	405,739	1,596,190	78,337

Apparatus and species.	Hillsboro.		Monroe.		Pinellas.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Seines:								
Bluefish			4,014	$280			4,014	$280
Mullet			7,313	511			7,313	511
Pompano			35	7			35	7
Spanish mackerel			122,486	8,576			122,486	8,576
Total			133,848	9,374			133,848	9,374
Gill nets: Turtles			40,250	2,610			40,250	2,610
Otter trawls: Shrimp							343,219	8,701
Lines:								
Amberfish							9,100	333
Cero and kingfish			28,750	1,976			28,750	1,976
Groupers	183,792	$7,447	4,000	240	82,915	$2,903	4,162,160	167,977
Grunts							4,220	179
Jewfish							43,100	1,738
King whiting							300	12
Leatherjacket or "turbot"							2,000	80
Porgies							12,900	498
Scamp							300	10
Sea bass							450	29
Snapper—								
Mutton			2,100	84			2,100	84
Red	344,797	22,277			306,636	16,523	6,011,297	373,124
Total	528,589	29,724	34,850	2,300	389,581	19,426	10,276,677	546,040
Dip nets: Sea crawfish			28,000	1,400			28,000	1,400
Sponge apparatus:								
Sponge—								
Glove			801	98			801	98
Grass			11,585	1,325			11,585	1,325
Sheepswool			22,213	29,205			22,213	29,205
Yellow			8,592	2,324			8,592	2,324
Total			43,191	32,952			43,191	32,952
Tongs: Oysters, market, public							76,461	4,822
Grand total	528,589	29,724	280,139	48,636	389,581	19,426	10,941,646	605,899

YIELD OF SHORE FISHERIES OF WEST COAST OF FLORIDA IN 1918, BY APPARATUS, COUNTIES, AND SPECIES.

BY SEINES.

Species.	Bay.		Calhoun.		De Soto.		Escambia.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Angelfish							850	$37
Black drum	275	$11			5,200	$156	1,000	40
Bluefish:								
Fresh	65,426	3,892	18,518	$1,067			31,710	1,902
Salted	12,240	915						
Blue runner, or hardtail:								
Fresh	150,703	2,261					50,130	1,252
Salted	52,810	2,010						
Bonito	23,897	956					22,000	880
Catfish					17,600	792		
Crevalle					8,625	280	18,000	720
Elops, or ten-pounder:								
Fresh	10,225	204			1,000	33	138,000	2,760
Salted	3,810	152						
Flounders	679	34	1,000	50	3,112	95	4,000	200
Grunts					789	26		
Hogfish					1,250	40		
King whiting					612	54	12,000	640
Menhaden:								
Fresh	13,325	299					145,702	3,642
Salted	4,360	174						
Moonfish	350	14						
Mullet:								
Fresh	259,960	11,696	63,075	2,132	874,340	34,973	184,460	11,067
Salted	815,820	62,104	77,840	4,800				
Mullet roe, salted	25,468	4,642	3,500	670				
Permit					1,416	46		
Pigfish	650	26			1,250	40	1,000	40
Pompano:								
Fresh	10,628	1,645	2,080	313	20,466	2,255	5,000	750
Salted	3,075	520						
Redfish, or red drum:								
Fresh	7,439	301	1,747	65	21,551	700	8,000	320
Salted	7,321	366						
Sailors choice					6,000	180		
Sergeantfish, or snook					25,650	834		
Sheepshead	6,757	270	1,000	30	50,084	1,627	9,000	360
Snapper, mangrove	430	17			8,208	267		
Spanish mackerel:								
Fresh	392,718	31,136	8,494	511			36,798	2,392
Salted	23,650	1,263						
Spot	1,570	63	550	16	5,136	167	1,500	90
Squeteagues, or "sea trout"	72,846	7,065	6,537	477	87,064	7,835	1,910	210
Yellowtail					1,125	33	8,000	320
Turtles							5,000	250
Total	1,966,432	132,036	184,341	10,131	1,140,478	50,433	684,060	27,872

YIELD OF SHORE FISHERIES OF WEST COAST OF FLORIDA IN 1918, BY APPARATUS, COUNTIES, AND SPECIES—Continued.

BY SEINES—Continued.

Species.	Franklin.		Hillsborough.		Lee.		Manatee.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Angelfish					4,003	$139	850	$34
Black drum	600	$19			4,625	115	13,890	312
Bluefish, fresh	14,171	820			7,602	684		
Blue runner, or hardtail, fresh	7,500	200			300	12		
Catfish					1,000	45		
Crevalle			200	$10	17,972	584	1,932	77
Elops, or ten-pounder, fresh	37,000	700			500	15	1,800	48
Flounders			250	13	1,258	39	2,930	118
Groupers					3,571	117		
Grunts					798	27	2,500	75
Hogfish					833	27	325	13
King whiting	2,100	116			818	72	1,370	80
Menhaden, fresh	5,000	100						
Mullet:								
Fresh	355,469	15,996	85,350	4,289	1,423,513	56,945	524,648	23,182
Salted	20,000	2,000						
Mullet roe, salted	2,500	625						
Permit					1,402	45	360	14
Pigfish					311	10	900	39
Pompano, fresh	760	96			11,657	1,317	1,800	270
Redfish, or red drum, fresh	12,414	558	600	28	120,267	3,909	33,245	1,409
Sailors choice					2,273	73	778	31
Sergeantfish, or snook			3,150	172	14,292	428	15,913	578
Sheepshead	1,200	54	100	7	146,606	4,764	45,985	1,941
Snapper, mangrove			50	2	5,525	181	10,836	433
Spanish mackerel, fresh	53,809	3,219			8,753	612		
Spot	1,250	29	425	21	5,470	177	1,642	71
Squeteagues, or "sea trout"	27,603	2,208	300	24	44,012	2,713	24,590	2,254
Yellowtail			2,200	112	565	17	5,350	226
Total	541,376	26,740	92,625	4,678	1,827,926	74,067	691,644	31,205

Species.	Okaloosa.		Pinellas.		Wakulla.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Angelfish			400	$12		
Black drum	280	$11				
Bluefish, fresh	12,858	772				
Blue runner, or hardtail, fresh	29,673	742				
Bonito	2,708	108				
Catfish	1,271	51				
Crevalle	478	19	400	16		
Elops, or ten-pounder:						
Fresh	72,752	1,455	208	4		
Salted	6,073	182				
Flounders	600	30	2,500	117		
Hogfish			500	20		
King whiting	3,215	183				
Menhaden:						
Fresh	40,177	1,004				
Salted	16,662	495				
Mullet:						
Fresh	145,438	8,726	365,329	15,439	75,000	$4,500
Salted	99,959	7,996			295,000	20,650
Mullet roe, salted					33,300	7,500
Permit			250	10		
Pompano, fresh	8,909	1,336				
Redfish, or red drum, fresh	893	36	2,413	114		
Sailors choice			3,300	159		
Sergeantfish, or snook			8,000	310		
Sheepshead	1,901	76	1,556	75		
Snapper, mangrove			500	25		
Spanish mackerel, fresh	143,747	9,343				
Spot	450	22	1,380	59		
Squeteagues, or "sea trout"	1,450	163	13,216	1,108		
Turtles	1,920	96				
Total	591,414	32,846	399,952	17,468	403,300	32,650

YIELD OF SHORE FISHERIES OF WEST COAST OF FLORIDA IN 1918 BY APPARATUS, COUNTIES, AND SPECIES—Continued.

BY SEINES—Continued.

Species.	Walton.		Total.	
	Pounds.	Value.	Pounds.	Value.
Angelfish			6,103	$222
Black drum			25,870	664
Bluefish:				
Fresh			150,285	9,137
Salted			12,240	915
Blue runner, or hardtail:				
Fresh			238,306	4,467
Salted			52,810	2,010
Bonito			48,605	1,944
Catfish			19,871	888
Crevalle			47,607	1,706
Elops, or ten-pounder:				
Fresh			261,485	5,219
Salted			9,883	334
Flounders			16,329	696
Groupers			3,571	117
Grunts			4,087	128
Hogfish			2,908	100
King whiting			20,115	1,145
Menhaden:				
Fresh			204,204	5,045
Salted			21,022	669
Moonfish			350	14
Mullet:				
Fresh	9,000	$540	4,365,582	189,485
Salted			1,308,619	97,550
Mullet roe, salted			64,768	13,437
Permit			3,428	115
Pigfish			4,111	155
Pompano:				
Fresh			61,300	7,982
Salted			3,075	520
Redfish, or red drum:				
Fresh			208,569	7,440
Salted			7,321	366
Sailors choice			12,351	443
Sergeantfish, or snook			67,005	2,322
Sheepshead			264,189	9,204
Snapper, mangrove			25,549	925
Spanish mackerel:				
Fresh			644,319	47,213
Salted			23,650	1,263
Spot			19,373	715
Squeteagues, or "sea trout"	3,000	300	282,528	25,357
Yellowtail			17,240	708
Turtles	100	5	7,020	351
Total	12,100	845	8,535,648	440,971

BY TRAMMEL NETS.

Species.	Escambia County.		Levy County.		Okaloosa County.		Pinellas County.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Angelfish	850	$37	200	$10				
Black drum	1,000	40	5,500	225				
Bluefish			300	24	100	$6		
Blue runner or hardtail	2,000	50						
Crevalle			1,050	52	400	16		
Flounders	3,300	165	825	66				
King whiting	2,000	120						
Mullet:								
Fresh	430,635	25,838			56,250	3,375		
Salted					318,000	25,440		
Permit							250	$10
Pigfish	1,000	40						
Pompano	3,703	555	1,950	293			8,794	1,319
Redfish or red drum	8,000	320	121,916	6,095	2,000	80	1,555	70
Sailors choice			300	15				
Sheepshead	8,000	320	126,274	1,314	1,800	72	4,115	205
Snapper, mangrove			1,400	70				
Spanish mackerel	1,650	107			500	35		
Spot	6,000	240						
Squeteagues or "sea trout":								
Fresh	13,642	1,500			50,000	5,000	18,437	1,561
Salted					30,000	3,600		
Total	481,780	29,332	259,715	8,164	459,050	37,624	33,151	3,165

YIELD OF SHORE FISHERIES OF WEST COAST OF FLORIDA IN 1918, BY APPARATUS, COUNTIES, AND SPECIES—Continued.

BY TRAMMEL NETS—Continued.

Species.	Santa Rosa County.		Wakulla County.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Angelfish					1,050	$47
Black drum			1,100	$44	7,600	309
Bluefish					400	30
Blue runner or hardtail					2,000	50
Crevalle			250	12	1,700	80
Flounders	300	$30	2,700	243	7,125	504
Hogfish	200	10			200	10
King whiting					2,000	120
Mullet:						
Fresh	120,000	6,000	33,800	1,521	640,685	36,734
Salted	9,000	720			327,000	26,160
Permit					250	10
Pigfish					1,000	40
Pompano					14,447	2,167
Redfish or red drum	1,000	50	7,120	320	141,591	6,935
Sailors choice			200	9	500	24
Sheepshead	1,800	90	2,725	123	144,714	2,124
Snapper, mangrove			500	23	1,900	93
Spanish mackerel			150	14	2,300	156
Spot	1,500	75			7,500	315
Squeteagues or "sea trout":						
Fresh	25,000	2,500	58,509	5,265	165,588	15,826
Salted					30,000	3,600
Total	158,800	9,475	107,054	7,574	1,499,550	95,334

BY GILL NETS.

Species.	Bay.		Calhoun.		Citrus.		De Soto.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Angelfish					310	$14		
Black drum					7,350	262		
Bluefish	6,817	$413	4,950	$300	490	40	37,908	$3,411
Blue runner or hardtail:								
Fresh	14,612	221					600	24
Salted	12,620	724						
Bonito	2,000	80						
Catfish							4,400	198
Crevalle					590	25	10,321	348
Elops or ten-pounder	750	15					3,280	101
Flounders			150	6	200	8		
King whiting							1,352	116
Mullet:								
Fresh	43,039	1,931	70,500	3,149	1,120,219	50,372	3,136,602	129,892
Salted	80,806	6,109						
Mullet roe, salted	2,739	483						
Permit							1,182	44
Pigfish			100	4				
Pompano	50	9	950	143	250	50	101,221	9,585
Redfish or red drum	670	28			41,091	1,940	81,161	3,187
Sailors choice					300	12		
Sheepshead	1,099	47	1,800	81	36,590	1,724	83,407	2,959
Snapper, mangrove					7,930	317	14,533	551
Spanish mackerel:								
Fresh	91,016	7,230	11,500	690			278,355	19,664
Salted	1,400	70						
Spot							1,284	43
Squeteagues or "sea trout":								
Fresh	37,311	4,038	12,700	1,016	92,440	8,421	328,842	29,595
Salted	1,125	112						
Yellowtail							182	7
Total	296,054	21,510	102,650	5,389	1,307,760	63,185	4,084,630	199,725

YIELD OF SHORE FISHERIES OF WEST COAST OF FLORIDA IN 1918, BY APPARATUS, COUNTIES, AND SPECIES—Continued.

BY GILL NETS—Continued.

Species.	Escambia.		Franklin.		Hernando.		Hillsborough.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Angelfish					50	$2	250	$10
Bluefish							50	4
Catfish			2,850	$112				
Crevalle					290	12	300	15
Flounders			4,142	217				
King whiting							300	18
Menhaden	48,568	$1,214	758	20				
Mullet:								
Fresh			265,244	13,582	198,000	7,920	592,493	24,276
Salted			93,020	7,251				
Mullet roe, salted			2,525	509				
Pompano	1,000	150	117	15			2,070	306
Redfish or red drum			635	26	4,570	182	12,900	537
Sheepshead			50	2	1,950	78	2,250	92
Snapper, mangrove					298	12	7,560	345
Spanish mackerel, fresh	85,628	5,566						
Spot							875	43
Squeteagues or "sea trout," fresh	2,250	247	13,115	944	4,980	398	35,000	2,400
Sturgeon	2,250	270	1,215	60				
Total	139,696	7,447	383,671	22,738	210,138	8,604	654,048	28,046

Species.	Jefferson.		Lafayette.		Lee.		Levy.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Angelfish					1,906	$63		
Black drum					1,050	20		
Bluefish					9,163	824	400	$32
Crevalle					9,877	322		
Elops or ten-pounder					500	15		
Flounders							1,325	106
King whiting					1,229	108		
Mullet:								
Fresh	72,000	$3,600	154,350	$7,718	2,507,051	99,281	1,200,154	60,008
Salted	31,500	2,205	72,615	5,083			5,000	350
Mullet roe, salted	1,230	230	1,250	250			1,700	340
Permit					190	6		
Pompano					20,900	2,372		
Redfish or red drum	850	42	4,150	208	36,492	1,206	42,389	2,120
Sailors choice							200	10
Sheepshead	230	11	2,000	100	157,462	5,116	14,265	714
Snapper, mangrove			900	45	2,354	77	200	10
Spanish mackerel, fresh					49,218	3,144	335	30
Spot					2,197	73		
Squeteagues or "sea trout," fresh	1,200	96	8,000	640	183,518	15,262	37,569	3,005
Sturgeon							1,450	290
Sturgeon, caviar							12	12
Yellowtail					93	3		
Turtles							8,500	620
Total	107,010	6,184	243,265	14,044	2,983,200	128,192	1,313,499	67,647

Species.	Manatee.		Monroe.		Okaloosa.		Pasco.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Angelfish	425	$17						
Black drum			500	$10				
Bluefish	10,184	951	12,000	1,200			550	$44
Blue runner or hardtail, fresh			2,000	60				
Crevalle	1,200	48					275	10
Elops or ten-pounder	1,325	40						
King whiting	375	22						
Mullet:								
Fresh	1,810,423	79,811	105,000	4,020			863,000	36,655
Salted					38,500	$3,080		
Permit	120	5						
Pompano	26,393	3,375	160	24				
Redfish or red drum	38,409	1,617	100	3			2,925	128
Sheepshead	28,813	1,252	300	12			875	35
Snapper, mangrove	6,147	245	1,000	40			980	39
Spanish mackerel:								
Fresh	147,463	12,884	1,938,890	135,722	900	58		
Salted					2,150	172		
Squeteagues or "sea trout":								
Fresh	135,068	13,270					8,635	691
Salted					500	60		
Turtles			9,000	788				
Total	2,206,345	113,537	2,068,950	141,879	42,050	3,370	877,240	37,602

YIELD OF SHORE FISHERIES OF WEST COAST OF FLORIDA IN 1918, BY APPARATUS, COUNTIES, AND SPECIES—Continued.

BY GILL NETS—Continued.

Species.	Pinellas.		Taylor.		Wakulla.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Angelfish	365	$15			150	$7	3,456	$128
Black drum					400	16	9,300	308
Bluefish	507	43			350	32	83,369	7,294
Blue runner or hardtail:								
Fresh					600	27	17,812	332
Salted							12,620	724
Bonito							2,000	80
Catfish							7,250	310
Crevalle	3,420	107			800	36	27,073	923
Elops or ten-pounder							5,855	171
Flounders	535	23			900	81	7,252	441
King whiting							3,256	264
Menhaden							49,326	1,234
Mullet:								
Fresh	1,863,935	71,511	285,850	$13,227	212,798	9,576	14,500,658	616,529
Salted			133,120	9,317	363,750	20,869	818,311	54,264
Mullet roe, salted			5,975	925	6,098	1,419	21,517	4,156
Permit							1,492	55
Pigfish							100	4
Pompano	5,978	897					159,089	16,926
Redfish or red drum	13,000	614	8,150	410	4,110	185	291,602	12,433
Sailors choice					200	9	700	31
Sheepshead	3,447	160	1,955	98	2,925	132	339,418	12,613
Snapper, mangrove	5,400	265			400	18	47,702	1,964
Spanish mackerel:								
Fresh	8,176	538			600	54	2,612,081	185,880
Salted							3,550	242
Spot	200	10	350	17	500	23	5,406	209
Squeteagues or "sea trout":								
Fresh	88,698	7,476	10,220	818	13,345	1,201	1,012,891	89,518
Salted							1,625	172
Sturgeon							4,915	620
Sturgeon, caviar							12	12
Yellowtail							275	10
Turtles					600	60	18,100	1,468
Total	1,993,661	81,659	445,620	24,812	608,526	33,745	20,068,013	1,009,315

BY STOP NETS.

Species.	De Soto.		Hillsborough.		Manatee.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Angelfish	5,256	$186	235	$10	725	$29
Black drum	12,600	378	1,050	31	1,000	45
Crevalle	22,341	763	1,956	93	2,600	104
Elops or ten-pounder					600	12
Flounders			350	18		
Groupers	8,992	292				
Grunts	789	26			2,500	75
Hogfish	1,036	44				
King whiting	517	45			2,200	132
Mullet	1,618,424	66,271	152,400	6,196	915,855	40,807
Permit	1,175	45			120	5
Pigfish	750	25	135	6	500	20
Pompano	206	27			150	20
Redfish or red drum	119,701	4,029	15,000	600	119,366	4,814
Sailors choice	3,831	133			250	10
Sergeantfish or snook			4,550	180		
Sheepshead	150,151	5,004	1,950	76	59,052	2,373
Snapper, mangrove	1,618	55	4,200	197	1,530	61
Spot			500	22	198	8
Yellowtail	220	9				
Total	1,947,607	77,332	182,326	7,429	1,106,646	48,515

YIELD OF SHORE FISHERIES OF WEST COAST OF FLORIDA IN 1918, BY APPARATUS, COUNTIES, AND SPECIES—Continued.

BY STOP NETS—Continued.

Species.	Pinellas.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*
Angelfish	1,600	$48	7,816	$273
Black drum			14,650	454
Crevalle	200	8	27,097	968
Elops or ten-pounder			600	12
Flounders	500	18	850	36
Groupers			8,992	292
Grunts			3,289	101
Hogfish	500	20	1,536	64
King whiting			2,717	177
Mullet	368,819	16,596	3,055,498	129,870
Permit			1,295	50
Pigfish			1,385	51
Pompano			356	47
Redfish or red drum	10,991	495	265,058	9,938
Sailors choice	1,300	58	5,381	201
Sergeantfish or snook			4,550	180
Sheepshead	9,338	420	220,491	7,873
Snapper, mangrove	2,570	138	9,918	451
Spot			698	30
Yellowtail			220	9
Total	395,818	17,801	3,632,397	151,077

BY LINES.

Species.	Bay County.		Citrus County.		De Soto County.		Escambia County.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Cero and kingfish					3,011	$240		
Groupers	138,645	$5,892			12,000	420	39,037	$1,144
Grunts					795	32		
Jewfish					5,332	160	850	34
Leather jacket or "turbot"	3,206	160					600	24
Porgy	32,907	1,316					685	24
Redfish or red drum					21,120	844		
Sergeantfish or snook					2,190	66		
Sheepshead			1,350	$53	16,500	660		
Snapper:								
Mangrove	540	21			9,890	395		
Red	347,678	22,599			12,000	840	81,907	4,702
Squeteagues or "sea trout"			8,643	795	67,261	6,144		
Yellowtail			1,500	60				
Total	522,976	29,988	11,493	908	150,099	9,801	123,079	5,928

Species.	Franklin County.		Hillsborough County.		Lee County.		Levy County.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Catfish	24,306	$1,928						
Groupers	121,947	5,004	8,389	$336			231,930	$8,277
Grunts							17,250	517
Jewfish					11,280	$226		
Porgy	550	22						
Sea bass	270	19					29,824	2,087
Snapper, red	92,390	6,443	8,450	591			3,000	240
Squeteagues or "sea trout"					27,725	2,217		
Total	239,463	13,416	16,839	927	39,005	2,443	282,004	11,121

YIELD OF SHORE FISHERIES OF WEST COAST OF FLORIDA IN 1918, BY APPARATUS, COUNTIES, AND SPECIES—Continued.

BY LINES—Continued.

Species.	Manatee County.		Monroe County.		Pinellas County.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Amberfish			2,000	$80			2,000	$80
Angelfish			800	48			800	48
Barracuda			1,500	30			1,500	30
Bluefish			600	60	2,000	$170	2,600	230
Blue runner or hardtail			9,000	360			9,000	360
Bonito			350	21			350	21
Catfish							24,306	1,928
Cero and kingfish	42,367	$2,542	366,195	25,643	25,537	1,502	437,110	29,927
Cowfish or "shellfish"			300	12			300	12
Crevalle			300	15			300	15
Groupers	24,280	961	50,144	2,649	825,234	29,146	1,451,606	53,829
Grunts	2,287	69	20,300	1,698	25,121	894	75,753	3,200
Hogfish			2,700	162			2,700	162
Jewfish			9,000	540	282	6	26,744	966
Leather jacket or "turbot"			1,500	75	450	18	5,756	277
Moonfish			300	9			300	9
Permit			1,400	64			1,400	64
Pompano			350	70			350	70
Porgy			9,700	582			43,842	1,944
Porkfish			2,400	144			2,400	144
Redfish or red drum							21,120	844
Sailors choice			2,200	110			2,200	110
Sea bass					1,000	40	31,094	2,146
Sergeantfish or snook							2,190	66
Sheepshead							17,850	713
Snapper:								
Mangrove			8,500	510			18,930	926
Mutton			12,000	480			12,000	480
Red			9,000	630	661,446	46,471	1,218,871	82,516
Spanish mackerel			3,900	312			3,900	312
Squeteagues or "sea trout"	22,680	2,162			23,972	1,963	150,281	13,281
Tang			600	30			600	30
Yellowtail			12,500	750			14,000	810
Total	91,614	5,734	537,539	35,084	1,568,042	80,210	3,582,153	195,560

BY OTTER TRAWLS AND DIP NETS.

Apparatus and species.	Escambia.		Franklin.		Monroe.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Otter trawls: Shrimp	28,526	$1,711	2,878,723	$70,996			2,907,249	72,707
Dip nets: Sea crawfish					283,915	$14,164	283,915	14,164
Total	28,526	1,711	2,878,723	70,996	283,915	14,164	3,191,164	86,871

BY TONGS.

Species.	Bay.		Citrus.		De Soto.		Escambia.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Oysters, market, public	11,760	$630	35,000	$2,000	7,560	$450	53,536	$3,824

Species.	Franklin.		Lee.		Levy.		Manatee.	
Oysters, market:	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Public	2,310,560	$102,290	10,500	$600	35,840	$2,048	875	$75
Private					13,496	771		
Total	2,310,560	102,290	10,500	600	49,336	2,819	875	75

Species.	Pinellas.		Santa Rosa.		Total.	
Oysters, market:	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Public	4,354	$310	56,000	$4,000	2,525,985	$116,227
Private					13,496	771
Total	4,354	310	56,000	4,000	2,539,481	116,998

YIELD OF SHORE FISHERIES OF WEST COAST OF FLORIDA IN 1918, BY APPARATUS, COUNTIES, AND SPECIES—Continued.

BY SPONGE APPARATUS.

Species.	Monroe County.		Pinellas County.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Sponges:						
Glove	1,221	$147			1,221	$147
Grass	17,378	1,986	44,070	$8,814	61,448	10,800
Sheepswool	33,068	43,807	220,887	602,769	253,955	646,576
Wire			9,324	2,817	9,324	2,817
Yellow	12,885	3,485	70,164	28,378	83,049	31,863
Total	64,552	49,425	344,445	642,778	408,997	692,203

BY OTHER APPARATUS.

Species.	Bay County.		Franklin County.		Lee County.		Levy County.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Angelfish							1,600	$80
Bluefish							5,500	440
Blue runner or hardtail							57,530	1,726
Crevalle							2,150	108
Flounders	1,825	$92	4,000	$320				
King whiting							6,800	408
Menhaden							10,000	500
Pompano							415	63
Redfish or red drum							9,550	478
Sea bass							100	5
Sheepshead							2,000	100
Spanish mackerel							23,615	1,889
Spot							5,000	250
Squeteagues or "sea trout"							19,398	1,552
Terrapin							2,475	206
Clams, hard					159,272	$13,936		
Total	1,825	92	4,000	320	159,272	13,936	146,133	7,805

Species.	Manatee County.		Monroe County.		Pinellas County.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Angelfish							1,600	$80
Barracuda			3,360	$202			3,360	202
Bluefish							5,500	440
Blue runner or hardtail							57,530	1,726
Crevalle							2,150	108
Flounders							5,825	412
King whiting							6,800	408
Menhaden							10,000	500
Pompano							415	63
Redfish or red drum							9,550	478
Sea bass							100	5
Sheepshead							2,000	100
Spanish mackerel							23,615	1,889
Spot							5,000	250
Squeteagues or "sea trout"							19,398	1,552
Tarpon			1,800	180			1,800	180
Crabs, stone	2,000	$100			22,500	$2,500	24,500	2,600
Sea crawfish			10,100	500			10,100	500
Terrapin							2,475	206
Clams, hard	1,600	400					160,872	14,336
Conch			2,000	100			2,000	100
Total	3,600	500	17,260	982	22,500	2,500	354,590	26,135

NOTES ON CERTAIN FISHERIES.

THE MULLET FISHERY.—In 1918 the catch of mullet constituted 45.85 per cent of the total quantity and 34.16 per cent of the total value of the fishery products of the west coast of Florida. Although the most important fishery of the Gulf States, its prosecution is confined largely to the west coast of Florida, 25,109,951 pounds, or 87.67 per cent of the total quantity, valued at $1,168,696, or 88.64

per cent of the total value, being accredited to this State. Of the total catch on the west coast of Florida, 22,569,736 pounds, valued at $973,129, was marketed fresh; 2,453,930 pounds, valued at $177,974, salted; and 86,285 pounds, valued at $17,593, represented salted roe. The apparatus of capture, arranged in the order of importance, as indicated by the catch taken, was as follows: Gill nets, 15,340,486 pounds; seines, 5,746,282 pounds; stop nets, 3,055,498 pounds; and trammel nets, 967,685 pounds.

The following table gives the yield of the mullet fishery of the west coast of Florida in various years from 1879 to 1918:

Items.	1879	1880	1889	1890	1895
Mullet:	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Fresh	1,058,083	....	8,794,586	10,650,959	12,310,953
Salted	2,504,422	....	2,728,785	2,968,254	5,714,134
Smoked	....	....	4,500	3,200	....
Mullet roe:					
Fresh	....	....	....	....	2,150
Salted	6,662	....	244,080	298,549	299,061
Total	3,569,167	2,028,250	11,771,951	13,920,962	18,326,298

Items.	1897	1902	[a] 1908	1918
Mullet:	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Fresh	11,639,615	22,223,685	[b] 16,008,000	22,569,736
Salted	2,503,703	2,589,190	....	2,453,930
Smoked				....
Mullet roe:				
Fresh	....	....	[2] 135,000	....
Salted	143,999	134,887	....	86,285
Total	14,287,317	24,947,762	16,143,000	25,109,951

[a] From data published by the Bureau of the Census. [b] Includes fresh and salted.

THE OYSTER FISHERY.—The catch of oysters in 1918 on public grounds was 2,602,446 pounds, or 371,778 bushels, valued at $121,049, and on private beds, 13,496 pounds, or 1,928 bushels, valued at $771. The greater part of the catch, or 341,003 bushels, is credited to Franklin County. Compared with 1911, there has been an increase in the catch of 186,244 bushels, and in the value of $12,348.

A summary of the catch of oysters on the west coast of Florida for various years from 1880 to 1918 is given in the table of comparative statistics of the oyster industry of the Gulf States on page 138.

THE RED SNAPPER FISHERY.—This fishery centers largely at Pensacola, the catch credited to Escambia County being 4,661,984 pounds, or 64.49 per cent of the catch of the west coast of Florida and 49.43 per cent of the catch of the entire Gulf coast. Of the other counties in which this fishery is of importance, Franklin is credited with 655,716 pounds, Bay with 564,139 pounds, and Hillsborough with 353,247 pounds. Compared with 1908, there has been a decrease in the catch of 428,832 pounds and an increase in the value of $23,640. Those engaged in the industry experience considerable difficulty in supplying the demand for this highly prized fish, while the catch of groupers taken with the red snapper exceeds the demand. Reference has been made elsewhere in this report to the Bureau's efforts to increase the demand for groupers to supply markets for all that may be caught, as the future of the red-snapper fishery is, in a measure, dependent upon the accomplishment of this end.

The following summary shows the quantity and value of red snapper caught on the west coast of Florida in certain years:

Year.	Pounds.	Value.	Year.	Pounds.	Value.
1889	3,469,370	$105,557	1902	8,074,066	$237,428
1890	4,172,942	123,799	1908 [1]	7,659,000	432,000
1895	4,886,396	154,536	1918	7,230,168	455,640
1897	5,314,487	171,234			

[1] From data published by the Bureau of the Census.

THE SPONGE FISHERY.—The sponge fishery appears to be in a state of equilibrium between the natural supply and the catch, and if it can be so maintained no concern need be felt for the future. There is a superabundance of small sponges, attributed to the gradually returning productiveness of the beds in comparatively shallow water which was depleted by the spongers a number of years ago. If these small sponges were permitted an additional year's growth these formerly exhausted beds would yield a larger quantity, and, owing to the higher value of the larger sizes, a much greater financial return to the spongers.

As landed, sponges are strung on wire or twine in bunches, 4⅚ feet in length and of an average weight of 6 pounds to the bunch. The weights used in the statistical tables are those taken after the sponges have been beaten and dried before they are baled for shipment. For the different grades these are as follows: Glove, wire, and yellow, each 1½ pounds per bunch; grass and large wool, 2½ pounds per bunch; and small wool, 1 pound per bunch.

The following tables show the extent of the sponge fishery on the Gulf coast of Florida for certain years from 1880 to 1918, and the price per pound for certain years from 1895 to 1918:

Kinds.	1880		1889		1890		1895	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Sheepswool							231,272	$363,107
Yellow							29,509	11,798
Grass							21,387	5,464
Other							23,952	6,502
Total	207,000	$200,750	316,559	$381,087	366,772	$438,682	306,120	386,871

Kinds.	1896		1897		1899		1900	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Sheepswool	149,724	$248,196	157,476	$240,599	153,700	$332,390	181,311	$483,263
Yellow	23,655	9,318	32,362	13,082	55,800	16,205	74,466	44,045
Grass	44,617	11,508	128,622	29,188	76,900	14,319	143,112	33,263
Other	18,315	3,990	13,086	3,171	18,000	5,000	19,236	7,114
Total	236,311	273,012	331,546	286,040	304,400	367,914	418,125	567,685

Kinds.	1901		1902		1908 [1]		1918	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Sheepswool	202,673	$422,561	133,518	$297,727			276,168	$675,781
Yellow	62,512	39,290	56,787	31,113			91,641	34,187
Grass	108,748	24,210	140,682	29,765			73,033	12,125
Other	21,627	6,679	15,902	5,817			11,346	3,062
Total	395,560	492,740	346,889	364,422	622,000	$545,000	452,188	725,155

[1] From data published by the Bureau of Census.

Kinds.	Average price per pound.								
	1895	1896	1897	1899	1900	1901	1902	1908[1]	1918
Sheepswool	$1.57	$1.66	$1.53	$2.16	$2.67	$2.08	$2.23	....	$2.44
Yellow	.39	.40	.40	.29	.59	.63	.55	....	.37
Grass	.26	.26	.23	.19	.23	.22	.21	....	.16
Other	.27	.22	.24	.28	.37	.31	.37	....	.27
Average	1.26	1.16	.86	1.21	1.36	1.25	1.05	$0.87	1.60

[1] From data published by the Bureau of the Census.

WHOLESALE FISHERY TRADE AND CANNING INDUSTRY.

In 1918 there were 77 wholesale fishery establishments on the west coast of Florida handling fresh and salt fish and oysters, valued at $250,877, with a cash capital amounting to $157,650, in which 455 persons were engaged and $240,030 paid in wages. There were in addition 7 establishments, valued at $300,510, engaged in canning shrimp, oysters, etc., and the preparation of by-products. The number of persons employed in these establishments was 451, and the wages paid amounted to $123,803.

The following table shows the extent of the canning industry, including by-products, on the west coast of Florida in 1918:

SHRIMP AND OYSTER CANNING INDUSTRY, INCLUDING BY-PRODUCTS, ON THE WEST COAST OF FLORIDA IN 1918.

Items.	Number.	Value.
Establishments	7	$300,510
Cash capital	....	61,700
Persons engaged	451	....
Wages paid	....	123,803
PRODUCTS.		
Shrimp, canned:		
No. 1—4½ ounces ......cans	1,922,912	208,423
No. 1—5 ounces ......do	973,008	101,355
No. 1½—8½ ounces ....do	83,280	15,420
Total	2,979,200	325,198
PRODUCTS—continued.		
Oysters, canned:		
No. 1—5 ounces ....cans	391,056	$40,972
Clams, fish, and turtles, ...cans and bottles	795,600	109,986
By-products ....pounds	446,746	15,611

FISHERIES OF ALABAMA.

The coastal fisheries of Alabama are less extensive than those of the other Gulf States. In 1918 the number of persons employed in the fisheries of this State was 783, of whom 85 were on fishing vessels, 33 on vessels transporting fishery products, 365 in the shore and boat fisheries, and 300 shoresmen in the wholesale fish establishments and other fishery industries. Compared with 1902, there was a decrease of 315 men, or 28.68 per cent.

The total investment in the fisheries of the State amounted to $334,741, as compared with $328,285 in 1902, representing an increase of 1.96 per cent. The items making up this total included 15 fishing vessels, valued with their outfit at $57,590; 16 transporting vessels, with a value, including outfit, of $21,625; 290 power, sail, and row-boats, valued at $38,190; fishing apparatus in the vessel and shore

fisheries valued at $15,266; shore and accessory property with a value of $178,170; and working cash capital amounting to $23,900.

The products in 1918 amounted to 5,609,219 pounds, with a value of $230,567. Compared with 1902 there was a decrease of 40.01 per cent in the quantity and 13.54 per cent in the value of the products. The species of chief importance were as follows: Mullet, 1,699,530 pounds, valued at $67,818; shrimp, 1,265,612 pounds, valued at $38,828; oysters, 1,031,891 pounds, or 147,413 bushels, valued at $39,670; and red snapper, 798,400 pounds, valued at $49,075.

FISHERIES, BY COUNTIES.

The following table gives, by counties, the number of persons employed, investment, and products of the fisheries of Alabama in 1918:

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF ALABAMA IN 1918, BY COUNTIES.

Items.	Baldwin.		Mobile.		Total.	
PERSONS ENGAGED.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
On vessels fishing			85		85	
On vessels transporting	15		18		33	
In shore fisheries	117		248		365	
Shoresmen	12		288		300	
Total	144		639		783	
INVESTMENT.						
Vessels fishing:						
Gasoline			11	$31,600	11	$31,600
Tonnage			198		198	
Outfit				9,490		9,490
Sail			4	15,000	4	15,000
Tonnage			210		210	
Outfit				1,500		1,500
Vessels transporting:						
Gasoline	6	$10,800	5	4,400	11	15,200
Tonnage	60		47		107	
Outfit		1,375		1,175		2,550
Sail	1	1,000	4	1,900	5	2,900
Tonnage	10		31		41	
Outfit		225		750		957
Sail and row boats	90	2,060	118	4,805	208	6,385
Power boats	8	2,475	74	28,850	82	31,265
Apparatus, vessel fisheries:						
Trammel nets			8	600	8	600
Lines				530		530
Otter trawls			3	120	3	120
Tongs			3	22	3	22
Apparatus, shore fisheries:						
Seines	1	500	2	100	3	600
Trammel nets	91	6,700	47	3,010	138	9,710
Gill nets	6	50			6	50
Otter trawls			43	1,720	43	1,720
Lines		50		40		90
Tongs	24	180	200	1,500	224	1,680
Minor apparatus		47		97		144
Shore and accessory property		885		177,285		178,170
Cash capital		800		23,100		23,900
Total		27,147		307,594		334,741
PRODUCTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Angelfish	3,450	$103	3,450	$175	6,900	$278
Black drum	8,775	417	3,425	176	12,200	593
Bluefish	5,000	155	3,750	120	8,750	275
Blue runner or hardtail	1,000	30	10,000	300	11,000	330
Catfish	25,760	573	14,903	329	40,663	902
Croaker	55,800	2,036	37,700	1,216	93,500	3,252
Flounders	14,357	1,146	24,250	1,154	38,607	2,300
Groupers			244,000	10,485	244,000	10,485
Grunts	600	7	2,100	42	2,700	59
Jewfish			2,000	75	2,000	75
King whiting	5,000	144	4,600	168	9,600	312
Mullet:						
Fresh	859,500	33,390	834,020	34,150	1,693,520	67,540
Salted	5,000	225	1,000	50	6,000	275
Roe			10	3	10	3
Pompano	1,341	184	3,625	615	4,966	799

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF ALABAMA IN 1918, BY COUNTIES—Continued.

Items.	Baldwin.		Mobile.		Total.	
PRODUCTS—continued.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Redfish or red drum	16,650	$755	6,600	$372	23,250	$1,127
Sea bass			600	30	600	30
Sharks	400	12	200	5	600	17
Sheepshead	15,400	725	12,650	740	28,050	1,465
Snapper, red			798,400	49,075	798,400	49,075
Spanish mackerel	1,934	112	2,350	165	4,284	277
Spot	21,300	822	20,400	601	41,700	1,423
Sturgeon	2,938	125			2,938	125
Sturgeon roe	60	45			60	45
Squeteagues or "sea trout"	36,875	1,746	101,755	4,865	138,630	6,611
Shrimp			1,265,612	38,828	1,265,612	38,828
Crabs, hard	25,800	965	70,050	2,327	[1] 95,850	3,292
Terrapin	763	224	2,175	880	2,938	1,104
Oysters:						
Market, public	15,750	775	635,376	21,915	[2] 651,126	22,690
Market, private	27,300	1,900	163,275	13,585	[3] 190,575	15,485
Seed, public	180,600	1,290	9,590	205	[4] 190,190	1,495
Total	1,331,353	47,916	4,277,866	182,651	5,609,219	230,567

[1] Represents 287,550 in number.
[2] Represents 93,018 bushels.
[3] Represents 27,225 bushels.
[4] Represents 27,170 bushels.

FISHERIES, BY APPARATUS.

The total yield of all forms of apparatus employed in the vessel fisheries, which included lines, trammel nets, otter trawls, and tongs, amounted to 1,335,173 pounds, valued at $75,963. The greater part of this total consisted of red snapper and groupers taken with lines.

In the shore or boat fisheries the catch amounted to 4,204,596 pounds, valued at $152,300. The most productive form of apparatus was the trammel net, the catch consisting of various species, chiefly mullet, amounting to 1,704,540 pounds, valued at $63,815. Otter trawls used in the capture of shrimp ranked second, with a catch of 1,224,574 pounds, valued at $37,616, and tongs used for taking oysters third, with a catch of 1,000,391 pounds, or 142,913 bushels, valued at $38,695.

The following tables give the products of the vessel and shore fisheries, by counties, in 1918:

YIELD OF VESSEL FISHERIES OF ALABAMA IN 1918, BY APPARATUS AND SPECIES.[1]

Species.	Lines.		Trammel nets.		Other trawls.		Tongs.		Total.	
	Lbs.	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*	*Lbs.*	*Value.*
Angelfish			1,200	$120					1,200	$120
Black drum			300	15					300	15
Croaker			9,000	420					9,000	420
Flounders			250	20					250	20
Groupers	244,000	$10,485							244,000	10,485
Jewfish	2,000	75							2,000	75
King whiting			1,500	75					1,500	75
Mullet:										
Fresh			180,020	10,800					180,020	10,800
Salted			1,000	50					1,000	50
Roe			10	3					10	3
Pompano			1,800	450					1,800	450
Redfish or red drum			600	60					600	60
Sharks			300	15					300	15
Sheepshead			1,300	128					1,300	128
Snapper, red	798,400	49,075							798,400	49,075
Spanish mackerel			600	65					600	65
Spot			2,100	105					2,100	105
Squeteagues or "sea trout"			18,255	1,815					18,255	1,815
Shrimp					41,038	$1,212			41,038	1,212
Oysters, market, public							31,500	$975	31,500	975
Total	1,044,400	59,635	218,235	14,141	41,038	1,212	31,500	975	1,335,173	75,963

[1] Vessel fisheries were conducted only in Mobile County in 1918.

YIELD OF SHORE FISHERIES OF ALABAMA IN 1918, BY COUNTIES, APPARATUS, AND SPECIES.

Apparatus and species.	Baldwin.		Mobile.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Seines:						
Angelfish	1,000	$30	900	$18	1,900	$48
Black drum	5,000	225	375	20	5,375	245
Bluefish	5,000	155	3,750	120	8,750	275
Blue runner or hardtail	1,000	30	10,000	300	11,000	330
Catfish	3,330	60	2,000	28	5,330	88
Croaker	10,000	350	600	12	10,600	362
Flounders	750	35	625	32	1,375	67
Grunts	100	3	100	2	200	5
King whiting	1,000	28			1,000	28
Mullet			12,000	360	12,000	360
Pompano	1,000	145	1,125	90	2,125	235
Redfish or red drum	3,750	170	3,750	210	7,500	380
Sharks			200	5	200	5
Sheepshead	2,500	115	625	35	3,125	150
Spanish mackerel	1,250	70	1,500	84	2,750	154
Spot	2,500	95	300	6	2,800	101
Squeteagues or "sea trout"	6,900	225	6,250	350	13,150	575
Total	45,080	1,736	44,100	1,672	89,180	3,408
Trammel nets:						
Angelfish	2,450	73	1,350	37	3,800	110
Black drum	3,775	192	2,750	141	6,525	333
Catfish	21,930	504	12,503	287	34,433	791
Croaker	45,800	1,686	28,000	780	73,800	2,466
Flounders	1,807	91	2,125	97	3,932	188
Grunts	500	14	2,000	40	2,500	54
King whiting	2,000	56	600	18	2,600	74
Mullet—						
Fresh	858,000	32,940	617,000	22,190	1,475,000	55,130
Salted	5,000	225			5,000	225
Pompano	341	39	700	75	1,041	114
Redfish or red drum	5,400	245	2,250	102	7,650	347
Sharks	400	12			400	12
Sheepshead	12,900	610	10,625	571	23,525	1,181
Spanish mackerel	684	42	250	16	934	58
Spot	18,800	727	18,000	490	36,800	1,217
Squeteagues or "sea trout"	15,725	1,021	10,875	494	26,600	1,515
Total	995,512	38,477	709,028	25,338	1,704,540	63,815
Gill nets:						
Sturgeon	2,938	125			2,938	125
Sturgeon roe	60	45			60	45
Total	2,998	170			2,998	170
Lines:						
Catfish	500	9	400	14	900	23
King whiting	2,000	60	2,500	75	4,500	135
Redfish or red drum	7,500	340			7,500	340
Sea bass			600	30	600	30
Squeteagues or "sea trout"	14,250	500	66,250	2,200	80,500	2,700
Crabs, hard	25,800	965	300	8	26,100	973
Total	50,050	1,874	70,050	2,327	120,100	4,201
Otter trawls: Shrimp			1,224,574	37,616	1,224,574	37,616
Tongs:						
Oysters—						
Market, public	15,750	775	603,876	20,940	619,626	21,715
Market, private	27,300	1,900	163,275	13,585	190,575	15,485
Seed, public	180,600	1,290	9,590	205	190,190	1,495
Total	223,650	3,965	776,741	34,730	1,000,391	38,695
Minor apparatus:						
Croakers			100	4	100	4
Flounders	11,800	1,020	21,250	1,005	33,050	2,025
Mullet	1,500	450	25,000	800	26,500	1,250
Sheepshead			100	6	100	6
Squeteagues or "sea trout"			125	6	125	6
Terrapin	763	224	2,175	880	2,938	1,104
Total	14,063	1,694	48,750	2,701	62,813	4,395
Grand total	1,331,353	47,916	2,873,243	104,384	4,204,596	152,300

WHOLESALE FISHERY TRADE.

In 1918 there were 16 wholesale fish establishments, including 2 engaged in the canning of shrimp and oysters and 1 in crushing oyster shells, valued at $175,850, with a cash or working capital of $23,900, employing 296 persons, to whom wages were paid amounting to $69,676. The output of canned shrimp and oysters and crushed oyster shells is included in the wholesale table for Mississippi.

FISHERIES OF MISSISSIPPI.

In 1918 Mississippi ranked fourth in quantity of fishery products taken and third in the value of the products. The number of persons engaged on fishing and transporting vessels was 667; in the shore fisheries, 673; and in the wholesale establishments, canneries, and other industries, 1,527, representing a total of 2,867.

The investment amounted to $1,433,585, which includes 160 fishing and transporting vessels, valued at $255,875, with a net tonnage of 2,090 tons and outfits valued at $41,065; 603 power and other boats, valued at $99,505; fishing apparatus employed on vessels to the value of $25,598; fishing apparatus employed on boats to the value of $19,383; shore and accessory property valued at $786,109; and cash capital amounting to $206,050.

The products amounted to 20,592,089 pounds, valued at $762,770, a decrease of 2,834,876 pounds, or 12.10 per cent, in quantity and an increase of 209,550, or 37.87 per cent, in value as compared with 1902. The catch of shrimp was 9,147,445 pounds, with a value of $319,595; oysters, 8,906,723 pounds, or 1,272,389 bushels, valued at $307,326; mullet, 1,453,431 pounds, valued at $64,262; squeteagues or "sea trout," 356,070 pounds, valued at $28,874; crabs, 225,025 pounds, valued at $7,882; and redfish, 115,685 pounds, valued at $8,135.

FISHERIES, BY COUNTIES.

The following table shows, by counties, the number of persons employed, the number and value of vessels, boats, and apparatus used, the amount of capital invested, and the quantity and value of the products of the fisheries in 1918:

Persons Engaged, Investment, and Products of the Fisheries of Mississippi in 1918, by Counties.

Items.	Hancock County.		Harrison County.		Jackson County.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.
PERSONS ENGAGED.								
On vessels fishing	35		549		17		601	
On vessels transporting			66				66	
In shore fisheries	63		444		166		673	
Shoresmen	154		1,334		39		1,527	
Total	252		2,393		222		2,867	
INVESTMENT.								
Vessels fishing:								
Gasoline			6	$9,300	4	$7,600	10	$16,900
Tonnage			53		34		87	
Outfit				1,565		1,075		2,640
Sail	7	$11,400	108	173,450			115	184,850
Tonnage	113		1,356				1,469	
Outfit		2,400		30,775				33,175

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF MISSISSIPPI IN 1918, BY COUNTIES—Continued.

Items.	Hancock County.		Harrison County.		Jackson County.		Total.	
INVESTMENT—continued.								
Vessels transporting:	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
Gasoline			10	$18,500			10	$18,500
Tonnage			124				124	
Outfit				2,195				2,195
Sail			25	35,625			25	35,625
Tonnage			410				410	
Outfit				3,055				3,055
Sail and row boats	75	$2,580	264	15,365	110	$4,040	449	21,985
Power boats			115	58,870	39	18,650	154	77,520
Apparatus, vessel fisheries:								
Trammel nets			2	200	6	600	8	800
Seines	7	1,960	72	17,600			79	19,560
Otter trawls			2	50			2	50
Lines						40		40
Dredges	10	300	161	4,800			171	5,100
Tongs			8	48			8	48
Apparatus, shore fisheries:								
Trammel nets	12	1,200	43	4,300	34	3,400	89	8,900
Seines			15	3,560	4	1,150	19	4,710
Otter trawls			95	2,375	6	150	101	2,525
Lines		80		135		148		363
Tongs	45	225	231	1,155	89	445	365	1,825
Other apparatus		1		999		60		1,060
Shore and accessory property		118,168		642,911		25,030		786,109
Cash capital		23,100		166,150		16,800		206,050
Total		161,414		1,192,983		79,188		1,433,585
PRODUCTS.								
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Angelfish			600	$30	300	$15	900	$45
Black drum	500	$20	8,760	263	4,517	224	13,777	507
Bluefish			500	40	2,066	150	2,566	190
Catfish			9,220	337	6,888	345	16,108	682
Croaker	5,200	312	23,000	1,135	12,400	470	40,600	1,917
Flounders	2,790	279	19,780	1,581	15,295	1,170	37,865	3,030
Groupers					24,656	863	24,656	863
Jewfish					8,800	288	8,800	288
King whiting	4,000	240	9,100	455	5,417	271	18,517	966
Menhaden			11,050	80			11,050	80
Mullet:								
Fresh	140,000	8,400	199,835	6,596	890,113	31,805	1,229,948	46,801
Salted			112,649	7,885	96,849	7,747	209,498	15,632
Mullet roe, salted			9,430	964	4,555	865	13,985	1,829
Pompano			480	79	3,809	609	4,289	688
Porgies					1,400	49	1,400	49
Redfish or red drum	12,000	960	37,636	2,676	66,049	4,499	115,685	8,135
Sea bass	250	30	2,560	209	1,570	121	4,380	360
Sharks			400	12			400	12
Sheepshead	7,250	725	9,668	705	50,694	3,052	67,612	4,482
Snapper, red					98,232	6,877	98,232	6,877
Spanish mackerel	1,250	125	9,037	741	1,244	100	11,531	966
Spot	4,000	200	11,945	431	3,145	143	19,090	774
Squeteagues or "sea trout"	132,000	13,240	104,748	7,405	119,322	8,229	356,070	28,874
Shrimp	644,800	22,568	8,404,000	293,295	98,645	3,732	9,147,445	319,595
Crabs:								
Hard	25,000	1,500	151,025	3,307	40,000	800	[1] 216,025	5,607
Soft			9,000	2,275			[2] 9,000	2,275
Terrapin	600	450	3,000	1,950	2,000	1,500	5,600	3,900
Turtles			337	20			337	20
Oysters, market:								
Public, from Mississippi beds	751,653	26,168	3,116,379	110,959	88,704	3,959	[3] 3,956,736	141,086
Public, from Louisiana beds			3,546,473	118,328			[4] 3,546,473	118,328
Private, from Mississippi beds			63,532	2,836	20,384	910	[5] 83,916	3,746
Private, from Louisiana beds	311,682	10,389	1,007,916	33,777			[6] 1,319,598	44,166
Total	2,042,975	85,606	16,882,060	598,371	1,667,054	78,793	20,592,089	762,770

[1] Represents 648,075 in number.
[2] Represents 27,000 in number.
[3] Represents 565,248 bushels.
[4] Represents 506,639 bushels.
[5] Represents 11,988 bushels.
[6] Represents 188,514 bushels.

FISHERIES, BY APPARATUS.

The catch of all forms of apparatus employed in the vessel fisheries in 1918 amounted to 13,613,605 pounds, valued at $464,404. The catch of oysters with dredges and tongs amounted to 7,633,983 pounds, or 1,090,569 bushels, valued at $251,011; shrimp, with seines and otter trawls, 5,677,200 pounds, valued at $198,402; various species with trammel nets, 184,407 pounds, with a value of $7,879; and red snapper, groupers, jewfish, and porgies, with lines, 118,015 pounds, valued at $7,112.

The products of the shore or boat fisheries amounted to 6,978,484 pounds, valued at $298,366. The largest quantity was taken with otter trawls, recently introduced in the fishery for shrimp, amounting to 3,248,070 pounds, valued at $113,309. The catch of oysters with tongs, which ranked second, was 1,272,740 pounds, or 181,820 bushels, valued at $56,315. Various species were taken with trammel nets, amounting to 1,108,094 pounds, valued at $60,876; with seines, amounting to 921,199 pounds, valued at $44,000; with lines, 345,943 pounds, valued at $15,353; and with minor appliances, amounting to 82,438 pounds, valued at $8,513.

The following tables give the products of the vessel and shore fisheries in 1918, by counties, apparatus, and species:

YIELD OF VESSEL FISHERIES OF MISSISSIPPI IN 1918, BY COUNTIES, APPARATUS, AND SPECIES.

Apparatus and species.	Hancock County.		Harrison County.		Jackson County.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Trammel nets:								
Angelfish					100	$5	100	$5
Black drum			560	$17	571	27	1,131	44
Bluefish					200	14	200	14
Croaker			500	25	1,950	67	2,450	92
Flounders			150	12	2,500	175	2,650	187
King whiting					976	49	976	49
Mullet			14,500	450	125,552	4,294	140,052	4,744
Redfish or red drum			8,000	560	8,318	582	16,318	1,142
Sea bass					200	16	200	16
Sheepshead					5,277	370	5,277	370
Spot					1,000	36	1,000	36
Squeteagues or "sea trout"			3,500	350	10,553	830	14,053	1,180
Total			27,210	1,414	157,197	6,465	184,407	7,879
Seines: Shrimp	644,800	$22,568	4,982,400	174,084			5,627,200	196,652
Lines:								
Groupers					23,063	807	23,063	807
Jewfish					8,000	260	8,000	260
Porgies					1,200	42	1,200	42
Snapper, red					85,752	6,003	85,752	6,003
Total					118,015	7,112	118,015	7,112
Otter trawls: Shrimp			50,000	1,750			50,000	1,750
Dredges:								
Oysters, market—								
Public, from Mississippi beds	653,121	21,770	2,339,841	76,744			2,992,962	98,514
Public, from Louisiana beds			3,261,573	105,891			3,261,573	105,891
Private, from Louisiana beds	311,682	10,389	1,001,616	33,402			1,313,298	43,791
Total	964,803	32,159	6,603,030	216,037			7,567,833	248,196
Tongs:								
Oysters, market—								
Public, from Mississippi beds			3,150	190			3,150	190
Public, from Louisiana beds			56,700	2,250			56,700	2,250
Private, from Louisiana beds			6,300	375			6,300	375
Total			66,150	2,815			66,150	2,815
Grand total	1,609,603	54,727	11,728,790	396,100	275,212	13,577	13,613,605	464,404

YIELD OF SHORE FISHERIES OF MISSISSIPPI IN 1918, BY COUNTIES, APPARATUS, AND SPECIES.

Apparatus and species.	Hancock County.		Harrison County.		Jackson County.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Trammel nets:								
Angelfish			300	$15	100	$5	400	$20
Black drum	500	$20	8,000	240	2,798	140	11,298	400
Bluefish			500	40	300	24	800	64
Catfish			5,220	182	200	10	5,420	192
Croaker	4,000	240	5,700	285	8,350	298	18,050	823
Flounders	540	54	1,700	136	1,795	131	4,035	321
King whiting			3,300	165	2,815	142	6,115	307
Mullet—								
Fresh	140,000	8,400	125,060	4,007	411,674	15,135	676,734	27,542
Salted			10,000	700			10,000	700
Pompano			350	58	90	14	440	72
Redfish or red drum	12,000	960	24,350	1,704	45,182	3,156	81,532	5,820
Sea bass			1,010	75	380	26	1,390	101
Sheepshead	6,000	600	6,300	441	41,790	2,459	54,090	3,500
Spanish mackerel			2,990	299	100	8	3,090	307
Spot	4,000	200	5,700	203	2,145	107	11,845	510
Squeteagues or "sea trout"	88,000	8,800	59,616	4,328	72,639	5,119	220,255	18,247
Terrapin	600	450			2,000	1,500	2,600	1,950
Total	255,640	19,724	260,096	12,878	592,358	28,274	1,108,094	60,876
Seines:								
Angelfish			200	10	100	5	300	15
Black drum			100	3	1,148	57	1,248	60
Bluefish					1,566	112	1,566	112
Catfish			3,000	105	810	41	3,810	146
Croaker			8,500	425	300	15	8,800	440
Flounders			1,350	108	1,400	102	2,750	210
King whiting			1,400	70	1,626	80	3,026	150
Menhaden			10,000	60			10,000	60
Mullet—								
Fresh			42,275	1,419	348,887	12,216	391,162	13,635
Salted			102,649	7,185	96,849	7,747	199,498	14,932
Mullet roe, salted			9,430	964	4,555	865	13,985	1,829
Pompano			50	8	3,669	587	3,719	595
Redfish or red drum			2,486	188	11,749	713	14,235	901
Sea bass			150	10	90	7	240	17
Sheepshead			1,568	120	3,427	207	4,995	327
Spanish mackerel			5,430	395	1,044	84	6,474	479
Spot			5,145	173			5,145	173
Squeteagues or "sea trout"			11,043	765	19,203	1,379	30,246	2,144
Shrimp			220,000	7,775			220,000	7,775
Total			424,776	19,783	496,423	24,217	921,199	44,000
Lines:								
Catfish			800	40	5,878	294	6,678	324
Croaker	1,200	72	6,800	335	1,800	90	9,800	497
Flounders			1,260	116	600	42	1,860	158
Groupers					1,593	56	1,593	56
Jewfish					800	28	800	28
King whiting	4,000	240	3,800	190			7,800	430
Pompano					50	8	50	8
Porgy					200	7	200	7
Redfish or red drum			300	24	800	48	1,100	72
Sea bass	250	30	900	84	900	72	2,050	186
Sheepshead	1,250	125	850	68	200	16	2,300	209
Snapper, red					12,480	874	12,480	874
Spanish mackerel	1,250	125	130	13	100	8	1,480	146
Spot			600	30			600	30
Squeteagues or "sea trout"	44,000	4,440	20,200	1,370	16,927	901	81,127	6,711
Crabs, hard	25,000	1,500	151,025	3,307	40,000	800	216,025	5,607
Total	76,950	6,532	186,665	5,577	82,328	3,244	345,943	15,353
Otter trawls: Shrimp			3,151,600	109,686	96,470	3,623	3,248,070	113,309
Other apparatus:								
Angelfish			100	5			100	5
Black drum			100	3			100	3
Catfish			200	10			200	10
Croaker			1,500	65			1,500	65
Flounders	2,250	225	15,320	1,209	9,000	720	26,570	2,154
King whiting			600	30			600	30
Menhaden			1,050	20			1,050	20
Mullet			18,000	720	4,000	160	22,000	880
Pompano			80	13			80	13
Redfish or red drum			2,500	200			2,500	200
Sea bass			500	40			500	40
Sharks			400	12			400	12

Yield of Shore Fisheries of Mississippi in 1918, by Counties, Apparatus, and Species—Continued.

Apparatus and species.	Hancock County.		Harrison County.		Jackson County.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Other apparatus—Continued.								
Sheepshead	....	....	950	$76	....	....	950	$76
Spanish mackerel	....	....	487	34	....	....	487	34
Spot	....	....	500	25	....	....	500	25
Squeteagues or "sea trout"	....	....	10,389	592	....	....	10,389	592
Shrimp	....	....	....	....	2,175	$109	2,175	109
Crabs, soft	....	....	9,000	2,275	....	....	9,000	2,275
Terrapin	....	....	3,000	1,950	....	....	3,000	1,950
Turtles	....	....	337	20	....	....	337	20
Total	2,250	$225	65,013	7,299	15,175	989	82,438	8,513
Tongs:								
Oysters, market—								
Public, from Mississippi beds	98,532	4,398	773,388	34,025	88,704	3,959	960,624	42,382
Public, from Louisiana beds	....	....	228,200	10,187	....	....	228,200	10,187
Private, from Mississippi beds	....	....	63,532	2,836	20,384	910	83,916	3,746
Total	98,532	4,398	1,065,120	47,048	109,088	4,869	1,272,740	56,315
Grand total	433,372	30,879	5,153,270	202,271	1,391,842	65,216	6,978,484	298,366

WHOLESALE FISHERY TRADE.

There were 29 wholesale fresh-fish establishments in the State in 1918, valued at $59,065, with a cash capital amounting to $31,250, in which 455 persons were engaged and $47,290 paid in wages. In addition to these, there were 21 establishments engaged in canning shrimp and oysters, valued at $723,094, with a cash capital amounting to $174,800. The number of persons engaged in the canning industry was 1,382 and the wages paid amounted to $307,560.

To avoid the disclosure of individual enterprise, the output of canned shrimp and oysters and crushed oyster shells in Alabama has been included in the following table, containing statistics of the canning industry and preparation of by-products for Mississippi:

Oyster and Shrimp Canning Industry, Including By-Products, in Mississippi in 1918.

Items.	Number.	Value.	Items.	Number.	Value.
Establishments	21	$723,094	Shrimp canned:		
Cash capital	....	174,800	No. 1 .... cans	[2] 6,550,344	$521,484
Persons engaged	1,382	....	No. 1½ .... do	[2] 449,568	99,872
Wages paid	....	307,560	Total	6,999,912	621,356
PRODUCTS.			Miscellaneous products .... cans	40,800	14,800
Oysters canned:			Crushed oyster shells (poultry food) .... pounds	[3] 5,320,000	22,080
3 ounces .... cans	34,632	3,207	Other products .... do	311,000	8,580
4 ounces .... do	946,896	95,678			
5 ounces .... do	[1] 4,004,664	437,628			
6 ounces .... do	29,880	4,188			
8 ounces .... do	[1] 917,448	174,391			
10 ounces .... do	401,472	84,379			
12 ounces .... do	3,840	960			
Total	6,338,832	800,431			

[1] Includes pack of one firm in Alabama.
[2] Includes pack of two firms in Alabama.
[3] Includes output of one firm in Alabama.

FISHERIES OF LOUISIANA.

Louisiana ranked second among the Gulf States in 1918 in the number of persons engaged, in the investment, and in the value of its fishery products. There were 65 persons employed on fishing vessels, 128 on vessels transporting fishery products, 2,093 in the shore or boat fisheries, and 1,905 on shore in fresh-fish establishments, canneries, etc., totaling 4,191 persons engaged in the fisheries, compared with 5,027 persons in 1902. The decrease was largely in the shore fisheries.

There were 88 fishing and transporting vessels, representing a net tonnage of 765 tons, with a value, including their outfit, of $187,610, and 1,762 power, sail, and row boats, valued at $350,140. The value of the fishing apparatus used in the vessel and shore fisheries amounted to $95,317; the value of the shore and accessory property to $671,621, and the cash capital to $170,500, representing a total investment in the fisheries of the State of $1,475,188, an increase of $685,465, or 86.79 per cent, as compared with 1902.

The products of the fisheries in 1918 aggregated 24,953,876 pounds, valued at $1,419,367. Compared with 1902, there was an increase in the quantity of 199,741 pounds, or 0.80 per cent, and $561,053, or 65.36 per cent, in the value of the products. Among the species of importance mention may be made of the following: Shrimp, 13,315,407 pounds, valued at $649,805; oysters, 7,855,421 pounds, or 1,122,203 bushels, valued at $494,299; squeteagues or "sea trout," 1,190,357 pounds, valued at $110,474; redfish or red drum, 565,899 pounds, valued at $46,945; catfish, 480,420 pounds, valued at $18,955; and croaker, 383,035 pounds, valued at $28,862.

FISHERIES, BY PARISHES OR COUNTIES.

The number of persons employed, the number and value of vessels, boats, and fishing apparatus used, the amount of capital invested, and the quantity and value of the products of the fisheries of Louisiana in 1918 are shown, by counties, in the following table:

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF LOUISIANA IN 1918, BY COUNTIES.

Items.	Calcasieu.		Cameron.		Jefferson.		Jefferson Davis.	
PERSONS ENGAGED.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
On vessels transporting	2		2		4			
In shore fisheries	3		15		488		4	
Shoresmen					318			
Total	5		17		810		4	
INVESTMENT.								
Vessels transporting:								
Gasoline					2	$5,000		
Tonnage					12			
Outfit						500		
Sail	1	$500	1	$600				
Tonnage	6		8					
Outfit		50		70				
Sail and row boats	1	30	9	250	97	2,680	1	$30
Power boats	1	500	2	400	137	86,600	1	500
Apparatus, shore fisheries:								
Seines	1	200	1	125	49	17,040	1	500
Trammel nets					6	450		
Lines				20		72		
Otter trawls					69	1,725		
Tongs			7	35	60	270		
Minor apparatus						4		
Shore and accessory property				100		122,615		
Cash capital						40,300		
Total		1,280		1,600		277,256		1,030
PRODUCTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Black drum	500	$25	1,000	$49	14,300	$429	400	$20
Catfish	1,800	90	21,400	1,070	43,263	1,408	1,200	60
Croaker					45,690	3,446		
Flounders					9,800	786		
Mullet					74,411	3,725		
Pompano					610	147		
Redfish or red drum	3,200	156	4,400	352	54,778	4,382	3,200	256
Sea bass					6,600	528		
Sharks					2,000	60		
Sheepshead	2,600	208	2,600	208	20,443	1,685	2,200	176
Spanish mackerel					860	129		
Spot					18,590	929		
Squeteagues, or "sea trout"	4,600	460	5,600	560	198,529	17,152	4,100	410
Yellowtail					2,000	100		
Shrimp, green					6,724,614	236,881		
Squid					560	56		
Crabs, hard					52,350	2,617		
Terrapin					18,000	6,000		
Turtles					4,360	218		
Oysters, market:								
Public			98,406	7,029				
Private					677,124	40,305		
Total	12,700	939	133,406	9,268	7,968,882	320,983	11,100	922

Persons Engaged, Investment, and Products of the Fisheries of Louisiana in 1918, by Counties—Continued.

Items.	Lafourche.		Orleans.		Plaquemines.	
PERSONS ENGAGED.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
On vessels fishing	5	....	24	....	3	....
On vessels transporting	14	....	52	....	4	....
In shore fisheries	284	....	177	....	296	....
Shoresmen	166	....	522	....	194	....
Total	469	....	775	....	497	....
INVESTMENT.						
Vessels fishing:						
Gasoline	1	$2,000	5	$10,300	1	$4,000
Tonnage	8	....	28	....	5	....
Outfit	....	475	....	2,000	....	1,100
Sail	....	....	14	16,570	....	....
Tonnage	....	....	154	....	....	....
Outfit	....	....	....	1,200	....	....
Vessels transporting:						
Gasoline	7	9,250	17	42,190	1	4,000
Tonnage	43	....	144	....	9	....
Outfit	....	1,405	....	6,750	....	300
Sail	....	....	3	11,700	1	600
Tonnage	....	....	70	....	9	....
Outfit	....	....	....	600	....	100
Sail and row boats	160	5,500	138	3,960	290	15,705
Power boats	98	27,400	38	13,850	124	57,700
Apparatus, vessel fisheries:						
Seines	....	....	12	3,360	....	....
Otter trawls	1	25	....	....	....	....
Dredges	....	....	15	450	....	....
Tongs	5	35	19	148	3	24
Apparatus, shore fisheries:						
Seines	33	9,740	30	3,100	16	5,200
Trammel nets	....	....	....	....	16	1,475
Cast nets	....	....	115	1,150	....	....
Lines	....	....	....	490	....	180
Otter trawls	48	1,300	....	....	12	300
Tongs	150	750	....	....	230	1,323
Minor apparatus	....	....	....	425	....	....
Shore and accessory property	....	27,507	....	229,370	....	67,058
Cash capital	....	8,500	....	55,500	....	20,700
Total	....	93,887	....	403,113	....	179,765
PRODUCTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Angel fish	....	....	360	$18	....	....
Black drum	5,300	$159	2,800	83	4,600	$138
Catfish	39,243	1,177	9,200	370	20,050	796
Croaker	71,085	4,975	147,700	11,536	42,850	2,774
Flounders	1,200	108	2,500	245	1,250	115
Groupers	....	....	20,000	1,000	....	....
Mullet	70,716	3,535	39,600	1,880	....	....
Redfish or red drum	74,066	5,925	50,750	4,052	74,270	5,935
Sea bass	8,100	648	400	40	....	....
Sheepshead	36,868	2,947	34,260	2,663	44,540	3,463
Snapper, red	....	....	60,000	4,000	....	....
Spanish mackerel	....	....	....	....	625	62
Spot	26,985	1,349	2,750	137	....	....
Squeteagues or "sea trout"	100,443	8,038	188,970	18,258	162,450	13,189
Yellowtail	200	10	....	....	....	....
Shrimp:						
Green	2,526,907	82,057	947,340	36,282	1,301,000	45,326
Dried	....	....	....	....	18,375	5,145
Crabs, hard	....	....	111,875	3,256	56,000	1,400
Oysters, market:						
Public	....	....	88,200	3,930	42,000	2,500
Private	998,340	59,425	577,500	20,900	2,819,852	166,151
Total	3,959,453	170,353	2,284,205	108,650	4,587,862	246,994

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF LOUISIANA IN 1918, BY COUNTIES—Continued.

Items.	St. Bernard.		St. Mary.		St. Tammany.	
PERSONS ENGAGED.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
On vessels fishing			29			
On vessels transporting			28			
In shore fisheries	177		165		4	
Shoresmen			122			
Total	177		344		4	
INVESTMENT.						
Vessels fishing:						
Gasoline			8	$15,400		
Tonnage			86			
Outfit				2,800		
Vessels transporting:						
Gasoline			14	20,500		
Tonnage			101			
Outfit				2,490		
Sail and row boats	81	$2,330	45	1,125	1	$30
Power boats	65	24,600	54	25,850	1	500
Apparatus, vessel fisheries:						
Seines			2	560		
Lines				20		
Dredges			8	240		
Apparatus, shore fisheries:						
Seines	13	5,500	5	500	1	200
Trammel nets	26	2,500				
Lines		70		220		
Otter trawls	12	300				
Tongs	40	200	150	1,200		
Shore and accessory property		1,400		31,874		
Cash capital				8,000		
Total		36,900		110,779		730
PRODUCTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Black drum	13,450	$403	600	$30		
Catfish	23,960	1,088	203,468	8,163		
Croaker	42,440	3,446	2,400	216	9,000	$720
Flounders	2,596	245				
Mullet	97,800	4,890	1,500	75	3,200	160
Pompano	100	20				
Redfish or red drum	109,220	8,737	3,600	324	3,800	304
Sheepshead	29,610	2,392	3,000	270	3,500	280
Spanish mackerel	290	35				
Spot	18,300	915				
Squeteagues, or "sea trout"	173,000	18,011	17,900	1,973	12,000	1,200
Shrimp:						
Green	500,000	19,610			6,000	300
Dried			50,000	12,500		
Crabs, hard	46,700	2,335	15,000	300		
Oysters, market:						
Public	690,648	20,444				
Private	249,879	7,431	307,545	17,988		
Total	1,997,993	90,002	605,013	41,839	37,500	2,964

Persons Engaged, Investment, and Products of the Fisheries of Louisiana in 1918, by Counties—Continued.

Items.	Terrebonne.		Vermilion.[1]		Total.	
PERSONS ENGAGED.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
On vessels fishing	4				65	
On vessels transporting	16		6		128	
In shore fisheries	396		84		2,093	
Shoresmen	583				1,905	
Total	999		90		4,191	
INVESTMENT.						
Vessels fishing:						
Gasoline	1	$5,000			16	$36,700
Tonnage	10				137	
Outfit		500				6,875
Sail					14	16,570
Tonnage					154	
Outfit						1,200
Vessels transporting:						
Gasoline	8	14,000	3	$3,500	52	98,440
Tonnage	46		26		381	
Outfit		1,735		425		13,605
Sail					6	13,400
Tonnage					93	
Outfit						820
Sail and row boats	225	6,750	24	650	1,072	39,040
Power boats	142	67,500	27	5,700	690	311,100
Apparatus, vessel fisheries:						
Seines					14	3,920
Lines						20
Otter trawls					1	25
Dredges	2	60			25	750
Tongs					27	207
Apparatus, shore fisheries:						
Seines	151	28,050	15	1,800	316	71,955
Trammel nets	14	1,050			62	5,475
Cast nets					115	1,150
Lines		50				1,102
Otter trawls	8	200			149	3,825
Tongs	355	2,485	39	196	1,031	6,459
Minor apparatus						429
Shore and accessory property		191,397		300		671,621
Cash capital		37,500				170,500
Total		356,277		12,571		1,475,188
PRODUCTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Angel fish					360	$18
Black drum	9,505	$475	2,000	$100	54,455	1,911
Catfish	110,786	4,431	6,050	302	480,420	18,955
Croaker	16,370	1,309	5,500	440	383,035	28,862
Flounders	3,950	395	250	25	21,546	1,919
Garfish, dried	6,500	455			6,500	455
Groupers					20,000	1,000
Mullet	36,925	1,477	1,025	52	325,177	15,794
Pompano	110	17			820	184
Redfish or red drum	175,315	15,778	9,300	744	565,899	46,945
Sea bass					15,100	1,216
Sharks					2,000	60
Sheepshead	90,157	7,212	6,750	540	276,528	22,044
Snapper, red					60,000	4,000
Spanish mackerel					1,775	226
Spot					66,625	3,330
Squeteagues, or "sea trout"	285,515	27,768	37,250	3,455	1,190,357	110,474
Yellow-tail					2,200	110
Shrimp:						
Green	566,000	22,024			12,571,861	442,480
Dried	665,171	312,180	10,000	3,500	743,546	207,325
Squid					560	56
Crabs, hard					[2] 281,925	9,908
Terrapin	5,406	1,578			23,406	7,578
Turtles					4,360	218
Oysters, market:						
Public					[3] 919,254	33,903
Private	1,207,122	141,203	98,805	6,993	[4] 6,936,167	460,396
Total	3,178,832	410,302	176,930	16,151	24,953,876	1,419,367

[1] Includes Iberia Parish.
[2] 93,975 in number.
[3] 131,322 bushels.
[4] 990,881 bushels. In addition to the oysters shown above, 695,153 bushels, valued at $162,494, were taken by Mississippi men from Louisiana beds, and 11,250 bushels, valued at $3,000, were taken by Texas men from Louisiana beds.

FISHERIES, BY APPARATUS.

The different forms of apparatus used in the vessel fisheries of Louisiana, in the order of their importance, based on the value of the catch, were: Seines, with 783,740 pounds of shrimp, valued at $39,702; dredges, with 888,594 pounds of oysters, valued at $35,605; tongs, with 372,750 pounds of oysters, valued at $19,712; lines, with 42,000 pounds of catfish, valued at $1,680; and otter trawls, with 18,500 pounds of shrimp, valued at $740. The total catch of the vessel fisheries amounted to 2,105,584 pounds, valued at $97,439.

The total yield of the shore or boat fisheries amounted to 22,848,292 pounds, valued at $1,321,928. Seines were the most productive form of apparatus used, the catch amounting to 9,600,274 pounds, valued at $601,843. The catch with tongs amounted to 6,594,077 pounds, valued at $438,982; with otter trawls, 5,381,428 pounds, valued at $198,653; with lines, 699,128 pounds, valued at $43,140; with trammel nets, 293,050 pounds, valued at $23,473; with cast nets, 125,500 pounds, valued at $5,075; and with minor apparatus, 154,835 pounds, valued at $10,762.

The products of the vessel and shore fisheries of Louisiana in 1918 are shown in the following tables, by counties, apparatus, and species:

YIELD OF VESSEL FISHERIES OF LOUISIANA IN 1918, BY COUNTIES, APPARATUS, AND SPECIES.

Apparatus and species.	Lafourche.		Orleans.		Plaquemines.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Seines: Shrimp, green			733,740	$27,202		
Otter trawls: Shrimp, green	18,500	$740				
Dredges:						
Oysters, market—						
Public			46,200	1,430		
Private			420,000	14,000		
Total			466,200	15,430		
Tongs:						
Oysters, market—						
Public			42,000	2,500	42,000	$2,500
Private	68,250	4,062	157,500	6,900	63,000	3,750
Total	68,250	4,062	199,500	9,400	105,000	6,250
Grand total	86,750	4,802	1,399,440	52,032	105,000	6,250

Apparatus and species.	St. Mary.		Terrebonne.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Seines:						
Shrimp—						
Green					733,740	$27,202
Dried	50,000	$12,500			50,000	12,500
Total	50,000	12,500			783,740	39,702
Otter trawls: Shrimp, green					18,500	740
Lines: Catfish	42,000	1,680			42,000	1,680
Dredges:						
Oysters, market—						
Public					46,200	1,430
Private	307,545	17,988	114,849	$2,187	842,394	34,175
Total	307,545	17,988	114,849	2,187	888,594	35,605
Tongs:						
Oysters, market—						
Public					84,000	5,000
Private					288,750	14,712
Total					372,750	19,712
Grand total	399,545	32,168	114,849	2,187	2,105,584	97,439

YIELD OF SHORE FISHERIES OF LOUISIANA IN 1918, BY COUNTIES, APPARATUS, AND SPECIES.

Apparatus and species.	Calcasieu.		Cameron.		Jefferson.		Jefferson Davis.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Seines:								
Black drum	500	$25	750	$37	14,300	$429	400	$20
Catfish	1,800	90	1,400	70	40,763	1,308	1,200	60
Croaker					39,490	3,024		
Flounders					1,100	88		
Mullet					70,311	3,520		
Pompano					560	137		
Redfish or red drum	3,200	156	3,400	272	48,778	3,902	3,200	256
Sea bass					6,600	528		
Sharks					2,000	60		
Sheepshead	2,600	208	2,100	168	18,643	1,541	2,200	176
Spanish mackerel					800	120		
Spot					18,390	919		
Squeteagues or "sea trout"	4,600	460	4,100	410	177,529	15,052	4,100	410
Yellowtail					2,000	100		
Shrimp, green					2,928,452	103,169		
Squid					560	56		
Total	12,700	939	11,750	957	3,370,276	133,953	11,100	922
Trammel nets:								
Catfish					1,500	60		
Croaker					5,000	350		
Mullet					4,100	205		
Redfish or red drum					4,500	360		
Sheepshead					900	72		
Spanish mackerel					60	9		
Spot					200	10		
Squeteagues or "sea trout"					12,000	1,200		
Total					28,260	2,266		
Otter trawls: Shrimp, green					3,796,162	133,712		
Lines:								
Black drum			250	12				
Catfish			20,000	1,000	1,000	40		
Croaker					1,200	72		
Flounders					100	10		
Pompano					50	10		
Redfish or red drum			1,000	80	1,500	120		
Sheepshead			500	40	900	72		
Squeteagues or "sea trout"			1,500	150	9,000	900		
Crabs, hard					52,350	2,617		
Total			23,250	1,282	66,100	3,841		
Minor apparatus:								
Flounders					8,600	688		
Turtles					4,360	218		
Terrapin					18,000	6,000		
Total					30,960	6,906		
Tongs:								
Oysters, market—								
Public			98,406	7,029				
Private					677,124	40,305		
Total			98,406	7,029	677,124	40,305		
Grand total	12,700	939	133,406	9,268	7,968,882	320,983	11,100	922

YIELD OF SHORE FISHERIES OF LOUISIANA IN 1918, BY COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Lafourche.		Orleans.		Plaquemines.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Seines:						
Angelfish			360	$18		
Black drum	5,300	$159	2,200	65	4,500	$135
Catfish	39,243	1,177	8,100	325	13,500	540
Croaker	71,085	4,975	58,100	4,448	34,820	2,248
Flounders	1,200	108	950	95	1,250	115
Mullet	70,716	3,535	39,600	1,880		
Redfish or red drum	74,066	5,925	33,300	2,664	65,525	5,236
Sea bass	8,100	648	400	40		
Sheepshead	36,868	2,947	28,070	2,235	39,520	3,062
Spanish mackerel					350	35
Spot	26,985	1,349	2,750	137		
Squeteagues or "sea trout"	100,443	8,038	92,170	8,482	121,350	10,645
Yellowtail	200	10				
Shrimp—						
Green	1,437,391	47,264	76,100	3,405	1,274,750	44,278
Dried					18,375	5,145
Total	1,871,597	76,135	342,100	23,794	1,573,940	71,439
Trammel nets:						
Black drum					100	3
Catfish					6,550	256
Croaker					8,030	526
Red fish or red drum					8,745	699
Sheepshead					5,020	401
Spanish mackerel					275	27
Squeteagues or "sea trout"					41,100	2,544
Total					69,820	4,456
Otter trawls: Shrimp, green	1,071,016	34,053			26,250	1,048
Cast nets: Shrimp			125,500	5,075		
Lines:						
Black drum			600	18		
Catfish			1,100	45		
Croaker			89,600	7,088		
Flounders			1,550	150		
Groupers			20,000	1,000		
Red fish or red drum			17,450	1,388		
Sheepshead			6,190	428		
Snapper, red			60,000	4,000		
Squeteagues or "sea trout"			96,800	9,776		
Crabs, hard					56,000	1,400
Total			293,290	23,893	56,000	1,400
Minor apparatus:						
Crabs, hard			111,875	3,256		
Shrimp			12,000	600		
Total			123,875	3,856		
Tongs: Oysters, market, private	930,090	55,363			2,756,852	162,401
Grand total	3,872,703	165,551	884,765	56,618	4,482,862	240,744

YIELD OF SHORE FISHERIES OF LOUISIANA IN 1918, BY COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	St. Bernard.		St. Mary.		St. Tammany.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Seines:						
Black drum	13,152	$394	600	$30		
Catfish	21,960	1,008	2,400	120		
Croaker	33,845	2,707	2,400	216	9,000	$720
Flounders	2,096	197				
Mullet	74,700	3,735	1,500	75	3,200	160
Pompano	100	20				
Red fish or red drum	74,743	5,979	3,600	324	3,800	304
Sheepshead	26,600	2,128	3,000	270	3,500	280
Spanish mackerel	150	18				
Spot	16,300	815				
Squeteagues or "sea trout"	110,400	11,665	17,900	1,973	12,000	1,200
Shrimp, green	122,000	6,110			6,000	300
Total	496,046	34,776	31,400	3,008	37,500	2,964
Trammel nets:						
Black drum	298	9				
Catfish	2,000	80				
Croaker	6,095	489				
Flounders	500	48				
Mullet	23,100	1,155				
Red fish or red drum	33,877	2,710				
Sheepshead	2,110	174				
Spanish mackerel	90	10				
Spot	2,000	100				
Squeteagues or "sea trout"	57,000	5,730				
Total	127,070	10,505				
Otter trawls: Shrimp, green	378,000	13,500				
Lines:						
Catfish			159,068	6,363		
Croaker	2,500	250				
Red fish or red drum	600	48				
Sheepshead	900	90				
Spanish mackerel	50	7				
Squeteagues or "sea trout"	5,600	616				
Crabs, hard	46,700	2,335	15,000	300		
Total	56,350	3,346	174,068	6,663		
Tongs:						
Oysters, market—						
Public	690,648	20,444				
Private	249,879	7,431				
Total	940,527	27,875				
Grand total	1,997,993	90,002	205,468	9,671	37,500	2,964

YIELD OF SHORE FISHERIES OF LOUISIANA IN 1918, BY COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Terrebonne.		Vermilion.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Seines:						
Angel fish					360	$18
Black drum	7,385	$369	2,000	$100	51,087	1,763
Catfish	110,786	4,431	6,050	302	247,202	9,431
Croaker	14,770	1,181	5,500	440	269,010	19,959
Flounders	500	50	250	25	7,346	678
Garfish, dried	5,300	371			5,300	371
Mullet	36,925	1,477	1,025	52	297,977	14,434
Pompano	110	17			770	174
Red fish or red drum	147,715	13,294	9,300	744	470,627	39,056
Sea bass					15,100	1,216
Sharks					2,000	60
Sheepshead	73,857	5,908	6,750	540	243,708	19,463
Spanish mackerel					1,300	173
Spot					64,425	3,220
Squeteagues or "sea trout"	239,815	23,258	37,250	3,455	921,657	85,048
Yellowtail					2,200	110
Shrimp—						
Green	506,000	19,684			6,350,693	224,210
Dried	615,171	172,180	10,000	3,500	643,546	180,825
Squid					560	56
Terrapin	5,406	1,578			5,406	1,578
Total	1,763,740	243,798	78,125	9,158	9,600,274	601,843
Trammel nets:						
Black drum					398	12
Catfish					10,050	396
Croaker	1,600	128			20,725	1,493
Flounders					500	48
Mullet					27,200	1,360
Red fish or red drum	21,000	1,890			68,122	5,659
Sheepshead	12,100	968			20,130	1,615
Spanish mackerel					425	46
Spot					2,200	110
Squeteagues or "sea trout"	33,200	3,260			143,300	12,734
Total	67,900	6,246			293,050	23,473
Otter trawls:						
Shrimp—						
Green	60,000	2,340			5,331,428	184,653
Dried	50,000	14,000			50,000	14,000
Total	110,000	16,340			5,381,428	198,653
Cast nets: Shrimp					125,500	5,075
Lines:						
Black drum	2,120	106			2,970	136
Catfish					181,168	7,448
Croaker					93,300	7,410
Flounders	3,450	345			5,100	505
Garfish, dried	1,200	84			1,200	84
Groupers					20,000	1,000
Pompano					50	10
Red fish or red drum	6,600	594			27,150	2,230
Sheepshead	4,200	336			12,690	966
Snapper, red					60,000	4,000
Spanish mackerel					50	7
Squeteagues or "sea trout"	12,500	1,250			125,400	12,692
Crabs, hard					170,050	6,652
Total	30,070	2,715			699,128	43,140
Minor apparatus:						
Flounders					8,600	688
Crabs, hard					111,875	3,256
Shrimp					12,000	600
Turtles					4,360	218
Terrapin					18,000	6,000
Total					154,835	10,762
Tongs:						
Oysters, market—						
Public					789,054	27,473
Private	1,092,273	139,016	98,805	6,993	5,805,023	411,50
Total	1,092,273	139,016	98,805	6,993	6,594,077	438,98
Grand total	3,063,983	408,115	[1] 176,930	16,151	22,848,292	1,321,928

[1] Includes the catch of several men living in Iberia County.

WHOLESALE FISHERY TRADE.

There were 35 wholesale establishments in the State of Louisiana in 1918 engaged in handling fresh fish or oysters. The total number of persons employed in these establishments was 622; the amount of wages paid during the year was $224,552; the investment, $168,183; and the cash capital utilized $52,500. Besides these, there were 23 establishments engaged in the canning of shrimp and oysters and in the preparation of by-products, valued at $486,838, using cash capital amounting to $118,000; and employing 1,193 persons, to whom $145,687 were paid in wages during the year. These establishments were distributed as follows: In Jefferson Parish, 9; in Lafourche Parish, 3; in Orleans Parish, 4; in Plaquemines Parish, 3; and in Terrebonne Parish, 4.

The following table contains the statistics of the canning industry and preparation of by-products for Louisiana in 1918:

OYSTER AND SHRIMP CANNING INDUSTRY, INCLUDING BY-PRODUCTS, IN LOUISIANA IN 1918.

Items.	Number.	Value.	Items.	Number.	Value.
Establishments	23	$486,838	PRODUCTS—continued.		
Cash capital		118,000			
Persons engaged	1,193		Shrimp, canned:		
Wages paid		145,687	No. 1 ... cans	4,686,000	$504,043
PRODUCTS.			No. 1½ ... do	399,744	86,912
Oysters, canned:			Total	5,085,744	590,955
3 ounces ... cans	24,048	2,505	Shrimp:		
4 ounces ... do	157,152	16,719	Dried ... pounds	603,259	194,388
5 ounces ... do	[1] 754,408	81,936	Bran ... do	460,000	10,145
6 ounces ... do	172,704	24,705	Crushed oyster shells (poultry food) ... pounds	[2] 6,908,000	39,097
8 ounces ... do	33,336	7,081			
10 ounces ... do	51,696	11,615			
12 ounces ... do	33,168	9,360			
Total	1,226,512	153,921			

[1] Includes a small quantity of 5½-ounce cans put up by a Texas firm.
[2] Includes output of two firms in Texas.

FISHERIES OF TEXAS.

In 1918 Texas ranked second among the Gulf States in the quantity of fishery products and fourth in the number of persons engaged, investment, and value of the products. Compared with 1902, there has been an increase in the number of persons engaged of 742, or 64.86 per cent; in the investment an increase of $516,376, or 138.17 per cent; in the quantity of products an increase of 16,970,356 pounds, or 210.95 per cent; and in their value an increase of $323,429, or 91.41 per cent. The number of persons employed in 1918 on fishing vessels was 357, in the shore and boat fisheries 1,070, and on shore in wholesale establishments 459, totaling 1,886.

The number of fishing vessels was 75, with a total net tonnage of 1,335 tons, valued, with their outfit, at $259,870; the number of boats was 950, valued at $119,320. The value of the fishing apparatus used in the vessel and shore fisheries amounted to $61,262, the value of the shore and accessory property amounted to $413,248, and the working cash capital to $36,400, representing a total investment of $890,100.

The total yield of the fisheries of Texas was 25,014,760 pounds, valued at $677,243. The quantities and values of the principal species were: Black drum, 1,873,436 pounds, valued at $44,394; menhaden, 14,118,340 pounds, valued at $103,080; redfish or red

drum, 1,336,535 pounds, valued at $80,468; red snapper, 1,243,002 pounds, valued at $93,720; squeteagues or "sea trout," 1,613,370 pounds, valued at $119,328; and oysters, 3,344,488 pounds, or 477,784 bushels, valued at $143,610.

FISHERIES, BY COUNTIES.

The following table gives, by counties, the number of persons engaged, the investment, and the products of the fisheries of Texas in 1918:

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF TEXAS IN 1918, BY COUNTIES.

Items.	Aransas County.		Brazoria County.		Calhoun County.		Cameron County.	
PERSONS ENGAGED.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
On vessels fishing	6				63			
In shore fisheries	150		8		72		112	
Shoresmen	13				128		21	
Total	169		8		263		133	
INVESTMENT.								
Vessels fishing:								
Gasoline					11	$9,800		
Tonnage					86			
Outfit						4,350		
Sail	1	$3,100			16	10,320		
Tonnage	21				116			
Outfit		2,000				3,835		
Boats, sail, row, etc	160	14,380	4	$50	103	9,395	32	$8,730
Boats, power	7	3,200	4	800	8	3,200		
Apparatus, vessel fisheries:								
Seines					12	2,100		
Trammel nets					1	100		
Gill nets					6	90		
Lines		100						
Dredges					2	100		
Tongs					48	182		
Apparatus, shore fisheries:								
Seines	32	3,500			17	1,900	28	5,600
Trammel nets	20	2,575	4	300	20	2,150		
Gill nets	180	5,175			70	750		
Cast nets					11	40	5	17
Fyke nets			4	300				
Lines		25				245		
Spears	27	20			20	14		
Tongs	80	400			56	385		
Minor apparatus		30						
Shore and accessory property		25,025		100		44,275		14,450
Cash capital		3,200				5,000		3,100
Total		62,730		1,550		98,231		31,897
PRODUCTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Black drum	119,000	$4,608			60,589	$2,915	1,083,486	$10,835
Bluefish	1,000	150			538	63		
Catfish	31,800	1,118			58,766	3,397	10,000	300
Croaker	30,375	1,155			15,818	734	15,000	525
Flounders	18,775	1,300			6,873	609	4,500	180
Jewfish							3,000	120
King whiting	565	38			3,496	331		
Mullet	11,625	448			9,000	418	10,000	100
Pompano	4,375	525			3,467	443	300	18
Redfish or red drum	119,250	8,415	11,875	$950	150,959	13,207	722,324	28,892
Sea:								
Bass							5,000	200
Gar	12,500	875			4,124	402	40,000	1,600
Sheepshead	18,750	873			20,938	1,718	20,000	800
Snapper, red	85,000	8,500						
Spanish mackerel	5,000	415			650	85		
Squeteagues or "sea trout"	228,369	22,895	13,750	1,100	186,366	19,120	722,324	28,892
Shrimp					3,500	260	1,500	50
Crabs, hard	384	11			360	11		
Turtles	431	13						
Oysters, market:								
Public	334,243	15,280			1,207,612	50,860	105	27
Private	10,500	480			10,500	525		
Total	1,031,942	67,099	25,625	2,050	1,743,556	95,098	2,637,539	72,539

Persons Engaged, Investment, and Products of the Fisheries of Texas in 1918, by Counties—Continued.

Items.	Chambers County.		Galveston County.		Harris County.	
PERSONS ENGAGED.	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
On vessels fishing			177		4	
In shore fisheries	45		202		100	
Shoresmen	4		60		15	
Total	49		439		119	
INVESTMENT.						
Vessels, fishing:						
Gasoline			9	$32,050	2	$1,000
Tonnage			188		13	
Outfit				9,000		450
Sail			11	61,600		
Tonnage			528			
Outfit				32,225		
Boats, sail, row, etc	30	$450	91	1,670	91	2,035
Boats, power	15	3,000	66	20,100	17	5,100
Apparatus, vessel fisheries:						
Seines			5	2,300	1	75
Lines				940		
Tongs			8	52		
Minor apparatus				1		
Apparatus, shore fisheries:						
Seines	9	900	8	1,835	15	1,800
Trammel nets			11	1,350		
Cast nets			10	35		
Lines		800		555		519
Spears			25	20		
Tongs			70	455	12	78
Minor apparatus		670		4		
Shore and accessory property		500		148,905		8,525
Cash capital		500		9,000		1,400
Total		6,820		322,097		20,982
PRODUCTS.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Angelfish					124	$7
Black drum	400	$20	7,750	$507	8,875	1,251
Catfish	68,100	5,448	16,080	1,011	25,370	1,365
Croaker	300	18	18,750	1,203	5,837	464
Flounders	500	43	7,425	990	1,535	178
Groupers			20,840	843		
Grunts			1,000	100		
Jewfish			27,340	1,534		
King whiting			21,000	2,138	2,950	391
Menhaden			4,574,340	31,500		
Mullet	600	12	2,500	92	11,300	429
Pompano			1,780	398	364	68
Redfish or red drum	1,000	60	26,625	3,265	28,725	3,791
Sheepshead	200	14	12,625	1,273	11,850	1,000
Snapper, red			1,146,002	83,720		
Spanish mackerel			3,750	710	244	37
Squeteagues or "sea trout"	1,500	125	32,125	4,245	41,175	6,170
Shrimp			9,000	719	2,000	175
Crabs:						
Hard			35,000	2,650	157,500	8,000
Soft					700	175
Terrapin					1,350	540
Oysters, market:						
Public			454,230	18,520	118,811	5,657
Private			26,250	2,350		
Total	72,600	5,740	6,444,412	157,049	418,710	29,693

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF TEXAS IN 1918, BY COUNTIES—Continued.

Items.	Jefferson County.		Matagorda County.		Nueces County.	
PERSONS ENGAGED.	Number.	Value.	Number.	Value.	Number.	Value.
On vessels fishing	54		31		22	
In shore fisheries	45		122		167	
Shoresmen	42		128		41	
Total	141		281		230	
INVESTMENT.						
Vessels fishing:						
Steam	2	$50,000				
Tonnage	217					
Outfit		14,800				
Gasoline	1	2,000	7	$5,235		
Tonnage	12		58			
Outfit		800		2,450		
Sail			10	6,000	5	$4,170
Tonnage			60		36	
Outfit				3,075		1,610
Boats, sail, row, etc	28	705	105	11,405	116	18,300
Boats, power	10	3,900	19	8,700	1	1,000
Apparatus, vessel fisheries:						
Seines	2	2,400	5	1,250	8	1,620
Trammel nets			2	160		
Lines		25		10		
Tongs			31	203	6	39
Apparatus, shore fisheries:						
Seines	7	750	14	2,900	60	8,140
Trammel nets			6	675		
Gill nets			10	100	13	1,100
Cast nets	2	7			100	300
Lines		50		155		500
Spears			25	15	25	25
Tongs	4	25	104	685		
Minor apparatus						6
Shore and accessory property		74,893		36,550		58,775
Cash capital		3,000		4,400		5,900
Total		153,330		83,968		101,485
PRODUCTS.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Black drum	2,200	$193	68,614	$3,230	514,972	$20,473
Bluefish			500	55		
Catfish	9,470	682	35,001	2,556	3,760	150
Croaker	3,125	290	81,052	3,796	25,000	1,000
Flounders	1,102	136	27,251	2,266	81,000	6,000
Jewfish	4,000	360	625	50	5,000	450
King whiting	600	60	5,813	275	1,000	40
Menhaden	9,544,000	71,580				
Mullet	1,000	60	4,375	135	1,875	45
Pompano			812	100	3,250	430
Redfish or red drum	11,800	1,590	71,500	5,990	170,477	12,110
Sea:						
Bass	1,625	150				
Gar			4,063	327	19,500	1,430
Sheepshead	7,375	749	24,124	1,975	70,500	3,450
Snapper, red	12,000	1,500				
Spanish mackerel			1,250	150	25,360	2,545
Squeteagues or "sea trout"	8,250	1,150	101,461	10,895	235,650	19,961
Shrimp	2,500	265	567	72	145,000	7,250
Terrapin	1,000	350	500	100		
Turtles	2,000	120	240	14	4,000	300
Oysters, market:						
Public	39,375	1,500	1,058,120	44,383	40,586	2,319
Private			4,781	209		
Total	9,651,422	80,735	1,490,649	76,578	1,346,930	77,953

PERSONS ENGAGED, INVESTMENT, AND PRODUCTS OF THE FISHERIES OF TEXAS IN 1918, BY COUNTIES—Continued.

Items.	Orange County.		San Patricio County.		Total.	
PERSONS ENGAGED.	Number.	Value.	Number.	Value.	Number.	Value.
On vessels fishing					357	
In shore fisheries	12		35		1,070	
Shoresmen			7		459	
Total	12		42		1,886	
INVESTMENT.						
Vessels fishing:						
Steam					2	$50,000
Tonnage					217	
Outfit						14,800
Gasoline					30	50,085
Tonnage					357	
Outfit						17,050
Sail					43	85,190
Tonnage					761	
Outfit						42,745
Boats, sail, row, etc	9	$690	21	$210	790	68,020
Boats, power	5	1,250	8	1,050	160	51,300
Apparatus, vessel fisheries:						
Seines					33	9,745
Trammel nets					3	260
Gill nets					6	90
Lines						1,075
Dredges					2	100
Tongs					93	476
Minor apparatus						1
Apparatus, shore fisheries:						
Seines	4	500	3	300	197	28,125
Trammel nets	1	125			62	7,175
Gill nets			6	600	279	7,725
Cast nets			10	35	138	434
Fyke nets					4	300
Lines		10		30		2,889
Spears			14	10	136	104
Tongs	4	25			330	2,053
Minor apparatus						710
Shore and accessory property		100		1,150		413,248
Cash capital				900		36,400
Total		2,700		4,285		890,100
PRODUCTS.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Angelfish					124	$7
Black drum	1,250	$110	6,300	$252	1,873,436	44,394
Bluefish			1,200	150	3,238	418
Catfish	2,800	305	1,500	75	262,647	16,407
Croaker	2,300	230			197,557	9,415
Flounders	400	47	13,000	1,085	162,361	12,834
Groupers					20,840	843
Grunts					1,000	100
Jewfish					39,965	2,514
King whiting	550	55			35,974	3,328
Menhaden					14,118,340	103,080
Mullet	1,000	70			53,275	1,809
Pompano			200	25	14,548	2,007
Redfish or red drum	3,800	560	18,200	1,638	1,336,535	80,468
Sea:						
Bass					6,625	350
Gar			700	63	80,887	4,697
Sheepshead	4,500	450	6,800	340	197,662	12,642
Snapper, red					1,243,002	93,720
Spanish mackerel			5,100	255	41,354	4,197
Squeteagues or "sea trout"	3,400	500	39,000	4,275	1,613,370	119,328
Shrimp					164,067	8,791
Crabs:						
Hard					[1] 193,244	10,672
Soft					[2] 700	175
Terrapin					2,850	990
Turtles					6,671	447
Oysters, market:						
Public	39,375	1,500			[3] 3,292,457	140,046
Private					[4] 52,031	3,564
Total	59,375	3,827	92,000	8,158	25,014,760	677,243

[1] Represents 579,732 in number.
[2] Represents 2,100 in number.
[3] Represents 470,351 bushels and includes 11,250 bushels, valued at $3,000, taken from Louisiana beds.
[4] Represents 7,433 bushels.

FISHERIES, BY APPARATUS.

The catch of all forms of apparatus used in the vessel fisheries amounted to 17,084,241 pounds, with a value of $278,409; in the shore or boat fisheries it amounted to 7,930,519 pounds, valued at $398,834. The catch in the vessel and shore fisheries with seines was 18,930,250 pounds, valued at $325,732; with trammel nets, 424,920 pounds, with a value of $34,773; with gill nets, 165,830 pounds, valued at $14,570; with lines, 1,869,716 pounds, valued at $140,260; and with tongs, 2,980,922 pounds, valued at $128,214. Various other forms of apparatus, such as dredges, cast nets, fyke nets, spears, etc., were employed, but the catch was relatively unimportant.

The products of the vessel and shore fisheries of Texas, by counties, in 1918 are shown in the following tables:

YIELD OF VESSEL FISHERIES OF TEXAS IN 1918, BY COUNTIES, APPARATUS, AND SPECIES.

Apparatus and species.	Aransas.		Calhoun.		Galveston.		Harris.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Seines:								
Bluefish			63	$7				
Black drum			9,558	483	1,750	$107		
Catfish			6,445	368	745	35	400	$20
Croaker			5,334	245	2,125	130	400	42
Flounders			959	89	125	15	100	11
King whiting			875	48	1,500	138	200	34
Menhaden					4,574,340	31,500		
Mullet			917	41			800	28
Pompano			875	113	280	41	25	4
Redfish or red drum			23,571	2,017	3,375	380	1,700	221
Sea gar			1,459	140				
Sheepshead			7,084	540	2,000	183	600	35
Spanish mackerel			500	65	500	72	20	3
Squeteagues or "sea trout"			22,225	2,280	3,625	425	1,800	270
Shrimp					1,000	79		
Total			79,865	6,436	4,591,365	33,105	6,045	668
Trammel nets:								
Black drum			1,500	70				
Catfish			16	1				
Croaker			37	2				
Mullet			313	15				
Redfish or red drum			2,706	230				
Sheepshead			162	13				
Squeteagues or "sea trout"			5,295	545				
Total			10,029	876				
Gill nets:								
Black drum			750	40				
Redfish or red drum			1,750	165				
Squeteagues or "sea trout"			3,750	385				
Total			6,250	590				
Lines:								
Groupers					20,840	843		
Jewfish					21,340	874		
Snapper, red	85,000	$8,500			1,146,002	83,720		
Total	85,000	8,500			1,188,182	85,437		
Dredges: Oysters, market, public			315,000	12,000				
Tongs: Oysters, market, public			654,031	27,835	73,500	3,220		
Minor apparatus: Flounders					800	125		
Grand total	85,000	8,500	1,065,175	47,737	5,853,847	121,887	6,045	668

YIELD OF VESSEL FISHERIES OF TEXAS IN 1918, BY COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Jefferson.		Matagorda.		Nueces.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Seines:								
Bluefish			250	$27			313	$34
Black drum			18,035	850	50,000	$1,875	79,343	3,315
Catfish			7,633	525	675	25	15,898	973
Croaker			17,761	832	2,750	110	28,370	1,359
Flounders			1,738	148	3,364	215	6,286	478
King whiting			1,600	76			4,175	296
Menhaden	9,544,000	$71,580					14,118,340	103,080
Mullet			562	27	370	10	2,649	106
Pompano			406	50	114	13	1,700	221
Redfish or red drum			20,875	1,717	9,167	550	58,688	4,885
Sea gar			1,938	155	1,435	90	4,832	385
Sheepshead			7,937	642	2,750	130	20,371	1,530
Spanish mackerel			625	75	88	10	1,733	225
Squeteagues or "sea trout"			27,543	2,932	14,665	1,100	69,858	7,007
Shrimp			283	36			1,283	115
Terrapin			250	50			250	50
Turtles			120	7			120	7
Total	9,544,000	71,580	107,556	8,149	85,378	4,128	14,414,209	124,066
Trammel nets:								
Black drum			625	30			2,125	100
Catfish			1,920	130			1,936	131
Croaker			406	19			443	21
King whiting			375	18			375	18
Mullet							313	15
Redfish or red drum			1,125	98			3,831	328
Sheepshead							162	13
Squeteagues or "sea trout"			1,750	195			7,045	740
Total			6,201	490			16,230	1,366
Gill nets:								
Black drum							750	40
Redfish or red drum							1,750	165
Squeteagues or "sea trout"							3,750	385
Total							6,250	590
Lines:								
Catfish			1,670	110			1,670	110
Groupers							20,840	843
Jewfish	4,000	360					25,340	1,234
Snapper, red	12,000	1,500					1,243,002	93,720
Total	16,000	1,860	1,670	110			1,290,852	95,907
Dredges: Oysters, market, public							315,000	12,000
Tongs: Oysters, market, public			302,869	12,700	10,500	600	1,040,900	44,355
Minor apparatus: Flounders							800	125
Grand total	9,560,000	73,440	418,296	21,449	95,878	4,728	17,084,241	278,409

YIELD OF SHORE FISHERIES OF TEXAS IN 1918, BY COUNTIES, APPARATUS, AND SPECIES.

Apparatus and species.	Aransas.		Brazoria.		Calhoun.		Cameron.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Seines:								
Black drum	88,750	$3,450			20,037	$972	1,083,486	$10,835
Bluefish	1,000	150			125	14		
Catfish	19,300	675			5,300	306	10,000	300
Croaker	27,625	1,050			5,979	276	15,000	525
Flounders	5,650	400			1,604	138	4,500	180
Jewfish							3,000	120
King whiting	565	38			1,156	96		
Mullet	8,750	335			2,646	122	10,000	100
Pompano	4,375	525			1,625	209	300	18
Redfish or red drum	86,250	6,100			46,114	3,953	722,324	28,892
Sea—								
Bass							5,000	200
Gar	10,000	700			2,603	257	40,000	1,600
Sheepshead	15,625	725			6,479	540	20,000	800
Spanish mackerel	2,500	200			119	16		
Squeteagues or "sea trout"	142,115	15,550			44,581	4,625	722,324	28,892
Total	412,505	29,898			138,368	11,524	2,635,934	72,462
Trammel nets:								
Bluefish					350	42		
Black drum	28,125	1,075			28,619	1,345		
Catfish	5,000	175			3,390	192		
Croaker	2,750	105			3,278	156		
Flounders					1,185	97		
King whiting					1,187	90		
Mullet	2,875	113			5,124	240		
Pompano					688	87		
Redfish or red drum	20,000	1,400	10,000	$800	66,818	5,978		
Sea gar	2,500	175			62	5		
Sheepshead	3,125	148			7,213	625		
Spanish mackerel					31	4		
Squeteagues or "sea trout"	41,629	3,500	11,250	900	91,515	9,375		
Total	106,004	6,691	21,250	1,700	209,460	18,236		
Gill nets:								
Black drum	2,125	83						
Catfish	7,500	268			1,085	65		
Croaker					1,190	55		
King whiting					278	97		
Pompano					279	34		
Redfish or red drum	10,500	745			5,250	440		
Squeteagues or "sea trout"	33,750	2,900			8,750	855		
Total	53,875	3,996			16,832	1,546		
Cast nets: Shrimp					3,500	260	1,500	50
Fyke nets:								
Redfish or red drum			1,875	150				
Squeteagues or "sea trout"			2,500	200				
Total			4,375	350				
Lines:								
Black drum					125	5		
Catfish					42,530	2,465		
Redfish or red drum	2,500	170			4,750	424		
Spanish mackerel	2,500	215						
Squeteagues or "sea trout"	10,875	945			10,250	1,055		
Crabs, hard	384	11			360	11		
Total	16,259	1,341			58,015	3,960		
Spears: Flounders	13,125	900			3,125	285		
Minor apparatus:								
Turtles	431	13						
Oysters, market, public							105	27
Total	431	13					105	27
Tongs:								
Oysters, market—								
Public	334,243	15,280			238,581	11,025		
Private	10,500	480			10,500	525		
Total	344,743	15,760			249,081	11,550		
Grand total	946,942	58,599	25,625	2,050	678,381	47,361	2,637,539	72,539

YIELD OF SHORE FISHERIES OF TEXAS IN 1918, BY COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Chambers.		Galveston.		Harris.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Seines:						
Angel fish					124	$7
Black drum	400	$20	3,125	$200	8,250	1,205
Catfish	100	8	1,670	80	5,000	265
Croaker	300	18	7,500	480	5,125	398
Flounders	500	43	500	64	1,125	131
King whiting			6,000	500	2,750	357
Mullet	600	12	1,000	45	10,500	401
Pompano			100	19	339	64
Redfish or red drum	1,000	60	8,750	1,050	19,525	2,570
Sheepshead	200	14	2,500	250	9,375	805
Spanish mackerel			125	19	224	34
Squeteagues or "sea trout"	1,500	125	10,000	1,280	20,625	3,100
Shrimp					2,000	175
Terrapin					1,350	540
Total	4,600	300	41,270	3,987	86,312	10,052
Trammel nets:						
Black drum			1,875	120		
Catfish			335	16		
Croaker			8,750	560		
Flounders			250	32		
King whiting			6,250	625		
Mullet			1,500	47		
Pompano			200	38		
Redfish or red drum			10,625	1,275		
Sheepshead			3,125	315		
Spanish mackerel			125	19		
Squeteagues or "sea trout"			11,250	1,440		
Total			44,285	4,487		
Cast nets: Shrimp			8,000	640		
Lines:						
Black drum			1,000	80	625	46
Catfish	68,000	5,440	13,330	880	19,970	1,080
Croaker			375	33	312	24
Flounders			750	114	310	36
Grunts			1,000	100		
Jewfish			6,000	660		
King whiting			7,250	875		
Pompano			1,200	300		
Redfish or red drum			3,875	560	7,500	1,000
Sheepshead			1,250	150	1,875	160
Spanish mackerel			5,000	600		
Squeteagues or "sea trout"			7,250	1,100	18,750	2,800
Crabs, hard			32,000	2,400	157,500	8,000
Total	68,000	5,440	78,280	7,852	206,842	13,146
Spears:						
Flounders			5,000	640		
Sheepshead			3,750	375		
Total			8,750	1,015		
Minor apparatus:						
Crabs—						
Hard			3,000	250		
Soft					700	175
Oysters, market, private			18,375	1,650		
Total			21,375	1,900	700	175
Tongs:						
Oysters, market—						
Public			380,730	15,300	118,811	5,657
Private			7,875	700		
Total			388,605	16,000	118,811	5,657
Grand total	72,600	5,740	590,565	35,881	412,665	29,030

YIELD OF SHORE FISHERIES OF TEXAS IN 1918, BY COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Jefferson.		Matagorda.		Nueces.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Seines:						
Black drum	1,500	$132	46,829	$2,200	461,972	$18,478
Bluefish			250	28		
Catfish	2,800	237	13,100	895	3,085	125
Croaker	3,000	280	60,729	2,843	22,250	890
Flounders	537	63	4,138	352	27,636	1,785
King whiting	600	60	3,400	160	1,000	40
Mullet	1,000	60	563	27	1,505	35
Pompano			406	50	3,136	417
Redfish or red drum	5,500	750	36,625	3,083	146,710	10,330
Sea—						
Bass	1,625	150				
Gar			2,125	172	18,065	1,340
Sheepshead	6,250	625	15,812	1,303	22,750	1,070
Spanish mackerel			625	75	272	35
Squeteagues or "sea trout"	5,125	700	59,043	6,383	172,985	14,061
Shrimp	1,500	185	284	36	5,000	250
Terrapin	1,000	350	250	50		
Turtles	2,000	120	120	7	1,000	150
Total	32,437	3,712	244,299	17,664	887,366	49,006
Trammel nets:						
Black drum			2,500	120		
Catfish			335	20		
Croaker			1,656	79		
Flounders			125	11		
King whiting			375	18		
Mullet			3,250	81		
Redfish or red drum			4,875	395		
Sheepshead			375	30		
Squeteagues or "sea trout"			9,250	955		
Total			22,741	1,709		
Gill nets:						
Black drum					3,000	120
Catfish			335	21		
Croaker			500	23		
King whiting			63	3		
Redfish or red drum			1,000	86	9,600	780
Squeteagues or "sea trout"			1,375	150	43,000	4,250
Total			3,273	283	55,600	5,150
Cast nets: Shrimp	1,000	80			140,000	7,000
Lines:						
Black drum	700	61	625	30		
Catfish	6,670	445	10,008	855		
Croaker	125	10				
Flounders	565	73				
Jewfish			625	50	5,000	450
Redfish or red drum	6,300	840	7,000	611	5,000	450
Sheepshead	1,125	124			45,000	2,250
Spanish mackerel					25,000	2,500
Squeteagues or "sea trout"	3,125	450	2,500	280	5,000	550
Total	18,610	2,003	20,758	1,826	85,000	6,200
Spears: Flounders			21,250	1,755	50,000	4,000
Minor apparatus:						
Turtles					3,000	150
Oysters, market, public					30,086	1,719
Total					33,086	1,869
Tongs:						
Oysters, market—						
Public	39,375	1,500	755,251	31,683		
Private			4,781	209		
Total	39,375	1,500	760,032	31,892		
Grand total	91,422	7,295	1,072,353	55,129	1,251,052	73,225

YIELD OF SHORE FISHERIES OF TEXAS IN 1918 BY COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Orange.		San Patricio.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Seines:						
Angel fish					124	$7
Black drum	1,000	$88	5,300	$212	1,720,649	37,792
Bluefish			200	30	1,575	222
Catfish	1,000	110	500	25	61,855	3,026
Croaker	1,500	150			149,008	6,910
Flounders	250	30	1,000	85	47,440	3,271
Jewfish					3,000	120
King whiting	400	40			15,871	1,291
Mullet	1,000	70			37,564	1,207
Pompano			200	25	10,481	1,327
Redfish or red drum	2,400	350	7,200	648	1,082,398	57,786
Sea—						
Bass					6,625	350
Gar			700	63	73,493	4,132
Sheepshead	3,000	300	800	40	102,791	6,472
Spanish mackerel			100	5	3,965	384
Squeteagues or "sea trout"	2,400	350	4,000	440	1,184,698	75,506
Shrimp					8,784	646
Terrapin					2,600	940
Turtles					3,120	277
Total	12,950	1,488	20,000	1,573	4,516,041	201,666
Trammel nets:						
Bluefish					350	42
Black drum	250	22			61,369	2,682
Catfish	300	30			9,360	433
Croaker	800	80			17,234	980
Flounders	150	17			1,710	157
King whiting	150	15			7,962	748
Mullet					12,749	481
Pompano					888	125
Redfish or red drum	800	120			113,118	9,968
Sea gar					2,562	180
Sheepshead	1,500	150			15,338	1,268
Spanish mackerel					156	23
Squeteagues or "sea trout"	1,000	150			165,894	16,320
Total	4,950	584			408,690	33,407
Gill nets:						
Black drum			1,000	40	6,125	243
Bluefish			1,000	120	1,000	120
Catfish					8,920	354
Croaker					1,690	78
King whiting					341	100
Pompano					279	34
Redfish or red drum			8,000	720	34,350	2,771
Sheepshead			1,000	50	1,000	50
Squeteagues or "sea trout"			19,000	2,075	105,875	10,230
Total			30,000	3,005	159,580	13,980
Cast nets:						
Spanish mackerel			5,000	250	5,000	250
Shrimp					154,000	8,030
Total			5,000	250	159,000	8,280
Fyke nets:						
Redfish or red drum					1,875	150
Squeteagues or "sea trout"					2,500	200
Total					4,375	350
Lines:						
Black drum					3,075	222
Catfish	1,500	165	1,000	50	163,008	11,380
Croaker					812	67
Flounders					1,625	223
Grunts					1,000	100
Jewfish					11,625	1,160
King whiting					7,250	875
Pompano					1,200	300
Redfish or red drum	600	90	3,000	270	40,525	4,415
Sheepshead			5,000	250	54,250	2,934
Spanish mackerel					30,500	3,315
Squeteagues or "sea trout"			16,000	1,760	73,750	8,940
Crabs, hard					190,244	10,422
Total	2,100	255	25,000	2,330	578,864	44,353

YIELD OF SHORE FISHERIES OF TEXAS IN 1918, BY COUNTIES, APPARATUS, AND SPECIES—Continued.

Apparatus and species.	Orange.		San Patricio.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Spears:						
Flounders			12,000	$1,000	104,500	$8,580
Sheepshead					3,750	375
Total			12,000	1,000	108,250	8,955
Minor apparatus:						
Crabs—						
Hard					3,000	250
Soft					700	175
Turtles					3,431	163
Oysters, market—						
Public					30,191	1,746
Private					18,375	1,650
Total					55,697	3,984
Tongs:						
Oysters, market—						
Public	39,375	$1,500			1,906,366	81,945
Private					33,656	1,914
Total	39,375	1,500			1,940,022	83,859
Grand total	59,375	3,827	92,000	8,158	7,930,519	398,834

WHOLESALE FISHERY TRADE.

The wholesale trade in fishery products in Texas in 1918 was conducted by 35 establishments, one of which canned a small quantity of oysters in addition to handling fresh fish and raw oysters; two produced crushed oyster shells, lime, and dust; and two were engaged in the manufacture of dried scrap and oil from menhaden, the remainder dealing principally in fresh fish and oysters. The wholesale establishments were valued at $396,288, used cash capital to the amount of $36,400, and employed 450 persons, to whom $150,330 were paid in wages during the year. In addition to the pack of oysters and the crushing of oyster shells for poultry food, which are included under Louisiana, other products having a value of $215,169 were prepared.

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